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SOME OBSERVATIONS ON THE USE OF INTRAVENOUS UROGRAPHY*

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SUFFICIENT experience has now accumulated since the introduction of intravenous urography to justify the opinion that this procedure is the most outstanding and noteworthy advance made in roentgenology during the past few years. Yet this opinion is not universally accepted, if one may judge from the criticism and dissatisfaction not infrequently expressed. These adverse opinions, we believe, arise, first, from a failure of many who have used the method to secure satisfactory roentgenograms and secondly, from a failure to appreciate adequately certain essential facts in the interpretation and evaluation of this new diagnostic procedure.

In the short time that has elapsed since intravenous urography became a practical clinical procedure, a considerable amount of literature has accumulated. Much of this relates to the manner in which the method came into being, dissertations regarding the chemistry of the various drugs used, the dosage and manner of administration, data concerning their elimination from the body, indications and contraindications for their use and the presentation of cases illustrating results obtained. Surprisingly little has been written regarding the details of the roentgenographic technique, and the principles of interpretation have been taken more or less for granted. Lack of knowledge regarding these two phases of the subject is the cause, we believe, for the failure of some to appreciate the true value of intravenous urography. Therefore, this paper has been confined to a few observations regarding the roentgenographic technique and the interpretation of results obtained by this method.

One of the most prevalent causes of poor results in any type of roentgenological examination of the urinary tract is the obscuration and the confusing shadows produced by the presence of intestinal contents, especially gas. This has long been a handicap to the roentgenologist and, though many methods have been devised for clearing out the alimentary canal, there is as yet none that gives satisfactory results in every case. In our early work with uroselectan our supply of the drug was exceedingly limited. It was highly essential, therefore, that none of it be wasted on a patient whose intestinal tract was poorly prepared. For this reason it became a routine practice with us to examine roentgenoscopically the abdomen of the patient before the injection of uroselectan was made. If the intestinal tract was found to

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contain too much gas, the patient was given a simple soapsuds enema, following which the abdomen was again examined roentgenoscopically. If there was still too much gas present, the roentgenologic examination was postponed until the following day after another attempt at elimination by means of purgatives. This method proved so helpful and valuable in eliminating this disturbing factor that it has been adopted as a routine procedure in all forms of roentgenological examinations of the urinary tract.

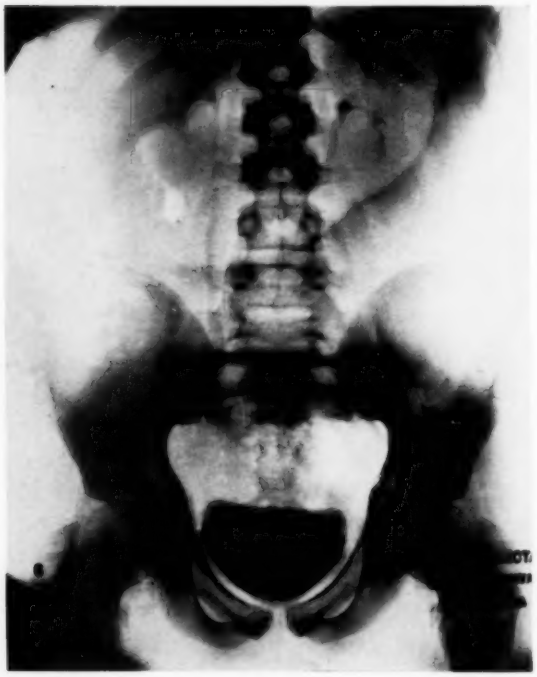

Fig. 1. Urogram made without the use of the compression bag. Note the inadequate visualization of the pelves and ureters. Compare with Figure 2.

It is probably the common experience of everyone using this method for the first time to be disappointed with their results. This is due to the fact that the shadows obtained are in no manner as striking as those to which we have become accustomed in the use of retrograde urography. One must be convinced of the fact that such results can probably never be attained where visualization depends upon the excretory power of the kidney. These organs have the power of excreting the shadow-casting drugs in a maximum concentration of about 5 per cent. The density of shadows resulting from such a concentration does not, of course, equal those obtained when a 10 to 15 per cent solution of sodium iodide is used as in the retrograde method.

Aside from this physiological factor, another cause for disappointment and criticism with intravenous urography is the frequency with which the pelves and ureters are inadequately distended with the opaque solution. Our earliest efforts were directed toward overcoming this objection. In the hope of securing more complete filling of these structures various procedures were resorted to. These included the use of a rubber compression bag over the lower abdomen, examining the patient in the Trendelenburg position, and increasing intravesical pressure to induce stasis in the upper tract. None of these, however, appeared to improve our results so that they were soon discarded. Furthermore, we were induced to abandon any attempt at producing urinary stasis by the fact that we felt this interfered with the normal function of the urinary organs and thus defeated one of the most valuable assets of this new method, namely, the depiction of the urinary tract under physiological conditions. However, I have since been convinced by Dr. Swick of New York, of the great value of the compression bag in securing adequate filling of the pelves and upper ureters, and I am indebted to him for the technique regarding its use.

The compression bag, the type commonly employed for compression purposes in other roentgen examinations of the abdomen, is a flat rubber bag measuring 12 inches in diameter. It is used moderately inflated. The adjustment of the bag to the abdomen is a matter of considerable importance. It is essential that its upper edge be placed above the lower costal border of the chest. If placed too low the circumference of the bag not infrequently appears across the kidney shadow, producing an effect that is rather confusing. Likewise, an

effort should be made to prevent the lower edge from coming across the shadow of the bladder. When properly placed the circumference of the bag will appear at the upper and lower corners of a 14″×17″ film, where it is often unnoticed. The bag is held in place by the muslin compression band which forms a part of the standard equipment of most roentgenographic tables. Only moderate pressure is required, never sufficient to cause the patient any discomfort. Care must be taken to have the bag so placed as to distribute its pressure equally over both sides of the abdomen so that one ureter does not receive a greater degree of pressure than the other. It is left in place for five minutes before and during the time of the roentgenographic exposure.

The use of the compression bag has very definitely improved our results (Figs. 1 and 2). The pelves and upper ureters are usually quite satisfactorily filled and not infrequently the appearance is quite comparable to that obtained by retrograde pyelography. While the use of the compression bag produces an artificial filling of the pelvis and ureter, we are in accord with Dr. Swick that it does not produce a distention of these structures that might lead to an erroneous interpretation of pathology. However, to eliminate this possibility of error absolutely, it is our routine practice for each film taken with the compression bag to make a duplicate one, just preceding it, without the bag. The films made without compression not only reveal the urinary tract under normal physiological conditions, but permit visualization of the lower portion of the ureters from which the dye is usually compressed when exposures are made with the bag. We have found the roentgenograms made without compression exceedingly valuable and consider them an essential part of the examination.

It would seem hardly necessary to mention the fact that preceding the intravenous injection a plain roentgenogram of the urinary tract should be made if this has not been done recently. Failure to do this has led us into error on several occasions. No doubt others have had the same experience. The following case will serve to emphasize this point in technique. Figure 3 shows a uroselectan study made on a man complaining of pain in the right side of the abdomen. There is noted what appears to

Fig. 2. This urogram was made five minutes after the one in Figure 1 during which time pressure was being made upon the abdomen by means of the compression bag. This has resulted in a more satisfactory filling of the upper urinary tract. Note the position of the bag.

be a satisfactory filling of both pelves. The slight enlargement and irregularity of the right would indicate an inflammatory type of hydronephrosis in a kidney whose function is apparently good. However, in the plain film (Fig. 4) what previously appeared as the dye-filled pelvis of the right kidney is now seen to be a large calculus forming a complete cast of the pelvis. As a matter of fact, none of the dye was excreted by the right kidney, indicating an absence of function. Without the plain film, the uroselectan examination would have led to an erroneous diagnosis.

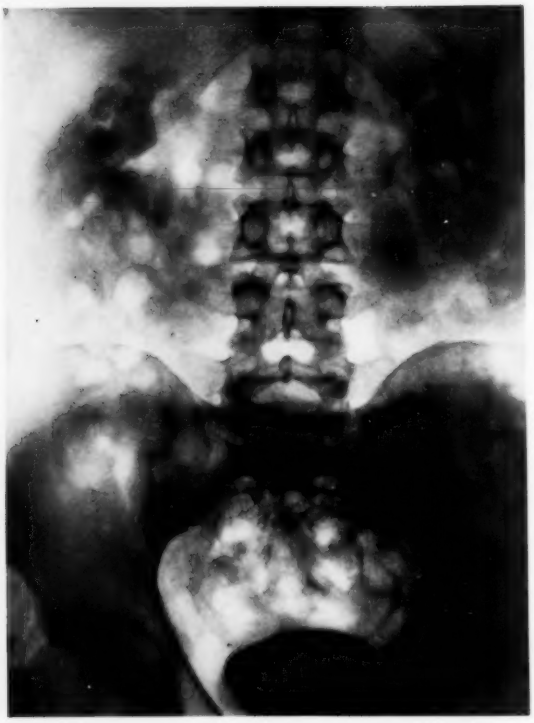

Fig. 3. An intravenous urogram in which both pelves are well shown, indicating good renal function bilaterally. Compare with Figure 4.

The exact time at which exposures should be made after the administration of the contrast medium is not a matter of vital importance, with the exception that the first one should be made within fifteen minutes and it is seldom necessary to continue the examination for more than two hours. The early films are often found to be the best of any series. A time interval of 15 minutes, 45 minutes and 1 hour and 15 minutes after the injection is the one usually advocated. A strict adherence to any time interval, however, is not essential. When the early films indicate a poor functional response on the part of the kidneys, it is advisable to lengthen the interval of time between exposures and to continue the examination beyond the usual time in order to gain the information desired.

The number of films made in this examination varies widely among different roentgenologists. We believe that multiple exposures are highly essential. Morphological and functional abnormalities to be of significance should be constant and present in every film. The number of exposures should not be less than three and these should be made at different times. In our own practice we make on an average from five to six in every case.

The size of the films to be used is a matter of individual preference. No doubt the most popular is the 14″×17″ size on which the entire urinary tract is depicted. This calls for careful anatomical localization as it is an easy matter to miss either the upper or lower portion of the tract. Some workers prefer a number of smaller films, for instance, two 10″×12″ films, using one for the upper and one for the lower portion of the tract. This has its advantage in that it insures inclusion of all the urinary organs

Fig. 4. The plain roentgenogram of the same patient as in Figure 3. The shadow taken to be the dye-filled right pelvis in the intravenous urogram is in reality a large branched calculus. None of the dye had been excreted by the right kidney indicating an absence of function.

and, furthermore, permits of better roentgenographic quality since the thicker portion of the body in the region of the kidneys requires a somewhat greater exposure than does the thinner portion comprising the lower ureters and bladder. However, we have adhered to the use of the larger size as we prefer to have the entire urinary tract on a single film. In the case of very obese or tall individuals, the use of separate films for the upper and lower abdomen is practically a necessity. Recently we have been making additional individual exposures of each kidney on 8″ × 10″ films in the hope of securing better detail. I am not convinced, however, that this has been of material aid as yet. Further use of such films will be necessary before a definite conclusion can be reached.

Not infrequently, roentgenograms are seen in which it appears that the patient has either moved or breathed during the exposure and the utmost care in instructing patients regarding such matters has failed to eliminate this blurred appearance. In shadows of the renal pelvis no denser than those so often obtained in intravenous urography, slight degrees of blurring, such as would be of little consequence in other types of roentgenological work, become of paramount importance. Careful examination will show that the blurring is not present in the fixed structures such as the spine or pelvis although it may be quite marked in those mobile organs such as the kidneys and the gas-filled intestines. It would appear, therefore, that the blurring is the result of transmitted movements, especially from the diaphragm, heart, aorta and renal arteries. That this is the probable cause is attested by the fact that the left kidney pelvis is the one usually showing the greatest degree of blurring and very often is blurred when the right is clear and distinct. Occupying a higher position directly under the diaphragm, the left kidney is more subject to transmitted movements from this structure than is the right, which is lower and protected more by the interposed large right lobe of the liver. Probably of more importance is the close proximity of the left kidney to the abdominal aorta. The marked pulsations of this vessel which can be felt so frequently through the abdominal wall are readily transmitted to the left kidney. Pulsations from the renal arteries act in a similar manner and on both sides. Of unquestionable importance in producing the indistinct shadow of the left kidney pelvis are the transmitted pulsations from the heart. One has but to observe the marked undulations occurring in the barium-filled stomach to appreciate the amount of movement transmitted to the abdominal organs by the rhythmic contractions of the heart.

That this blurring is a matter of vital importance in intravenous urography can be readily appreciated and since it is practically impossible to eliminate the above factors responsible for this condition, the next best procedure is to minimize these influences as much as possible. This can be done to a certain extent by making the roentgenographic exposures as rapidly as possible. With the improvement that has occurred in roentgenological equipment in the past few years it is now possible to secure satisfactory roentgenograms in much less time than formerly. Using a fast Potter-Bucky diaphragm, a 6 kw Müller tube, 75 milliamperes, 88 kilovolts, at a 30-inch target film distance, a satisfactory exposure of the urinary tract of an average adult can be made in one second. This technique has given clearer and more sharply defined shadows than were formerly obtained when the exposure time ranged from three to six seconds.

It is not advisable to adhere strictly to any definite roentgenological technique. This should be altered to suit the needs of the individual case. For this reason, it is essential that the roentgenologist acquaint himself with the history and clinical findings of the patient before making the intravenous examination. We have made it a rule to develop the first films immediately after they have been exposed and these are examined before any additional ones are

made. Occasionally, the findings in these wet films cause us to alter our technique or, rarely, to discontinue the examination altogether. Examining the wet films has the additional advantage of enabling the technician to change the roentgenographic exposure, if necessary, to determine whether or not the entire urinary tract has been included and whether the compression bag has been properly placed and adjusted. Any such errors can be corrected before the subsequent exposures are made. Likewise, where the wet films reveal poor visualization of the urinary organs due to inadequate renal function, subsequent exposures may be delayed and the examination continued beyond the usual time.

The question of stereoscopic films is again a matter of individual preference. For a long time one pair of stereoscopic roentgenograms was a part of our routine technique. We have since discontinued this practice in order to reduce the number of exposures. Stereoscopic films are now made only when conditions exist in which they seem especially indicated, such as the accurate localization of shadows found in the plain film to determine their relationship to the urinary tract.

There is one item in technique which we have found of particular value. This has been the exposure of one film with the patient in the erect posture to determine the degree of mobility of the kidneys. It goes without saying that this exposure is made without the compression bag and with an erect Potter-Bucky diaphragm. Unless there is some obstructive lesion present, the pelves and ureters in the erect film are invariably poorly visualized. We have made this exposure at various intervals following the injection but have found that the time is of no importance, the dye evidently passing by the force of gravity into the bladder as soon as the patient assumes the erect posture. Recognizing this fact, it would appear to be of advantage to keep the patient in the recumbent posture during the entire time of the examination in order to secure the best possible filling of the upper urinary tract.

The erect roentgenogram, due to poor visualization, is of little value in detecting morphological changes in the urinary organs. It does, however, give valuable information regarding the abnormalities resulting from downward displacement of the kidney. Making an erect film in every case enables one to determine the true significance of renal ptosis. Not infrequently, the entire symptomatology can be explained on the basis of the altered anatomy and physiology incident to ptosis. But when it is found that in almost every individual there is some descension of the kidneys, especially the right, one becomes impressed with the fact that renal ptosis is of significance only when producing definite demonstrable changes and when all other causes for the patient's symptoms have been excluded.

Various writers have called attention to the necessity of having the patient's bladder empty at the time of the roentgenographic exposures so as not to obscure the lower portion of the ureters by the opaque fluid in the bladder. For a long time it was our practice to have the patient void just before the second exposure was made. We have observed, however, that the bladder shadow tends to accentuate rather than diminish the visibility of the ureter when superimposed upon it, and calculi in the lower ureter are often more readily detected than when the bladder is empty. This is in accord with the experience of Swick. Consequently, we have for some time discontiuued the practice of having the patient void.

The roentgenological technique briefly summarized is as follows: The patient is prepared by the administration of an ounce and one-half of castor oil or two teaspoonfuls of compound licorice powder the evening before the examination. Children are given doses in proportion to age. A light breakfast is permitted the morning of the examination. This often secures an evacuation of the bowels by stimulating peristal-

tic activity. At eight-thirty in the morning, the patient's abdomen is examined roentgenoscopically. If the preparation has been satisfactory, a single 14″×17″ film of the urinary tract is made, if this has not been done recently. Following this, the dye is injected intravenously by a member of the Urological Staff. Fifteen minutes after the injection, a 14″×17″ film is made with the patient in the supine position. The compression bag is then applied and, after five minutes, the second film is made. A third one is made with the patient in the erect posture. These films are then developed immediately and examined before the next exposures are made. Approximately one-half hour later, or forty-five minutes after the injection, another film is made in the supine position, followed by one with the compression bag. The position of the kidneys having been determined from the wet recumbent films, an 8″×10″ film is made of each kidney, using a cone 5½ inches long with a 3½ inch opening at the large end. This completes the examination in the average case, six 14″×17″ and two 8″×10″ films having been used, including the plain one before the injection. The physical factors employed are 75 ma. current, one second exposure time, at a 30-inch target film distance. These factors are kept constant. The variable factor is the voltage which varies between 75 and 95 kilovolts, depending upon the thickness of the patient's abdomen, measured in inches. As has been stated, this technique is altered whenever existing conditions indicate.

One of the important aspects of intravenous urography is the appreciation of the fact that the roentgenological interpretation differs considerably from that employed in retrograde urography. It is not alone sufficient to be thoroughly familiar with the morphological changes incident to the various pathological processes that may occur in the urinary organs but one must be competent to interpret functional activity and to evaluate the effect of such activity upon the morphological changes present. A thorough understanding of the dynamics of the urinary tract is highly essential. Thus intravenous urography has opened up a new method for studying the physiology of the urinary system. Physiological phenomena, as revealed in the roentgenograms, have a definite bearing upon interpretation, for instance, the extent of visualization of the ureters which may be expected in the normal urinary tract. We do not believe that the normal ureter in adults is ever completely and persistently visualized. It may rarely be seen throughout its course in a single film, probably the result of a temporary hyperfunction of the kidney. The other films of the series will show the ureter only partially filled with the opaque medium. This is due to the fact that during systolic contraction of the ureter the dye is forced into those portions undergoing diastolic relaxation which are the only portions of the ureter to be seen on the roentgenogram. Therefore, complete and persistent visualization of the ureter, we believe, is indicative of obstruction at its lower end. It is important to recognize that the ureter need not be dilated. Such obstruction may be due to an opaque or non-opaque calculus, an inflammatory or neoplastic process or rarely to spasm. This fact, however, does not apparently hold true in children, where we quite commonly find complete filling of the ureters in the absence of any demonstrable pathology.

Uniformly good results should not be expected with intravenous urography. Pelves and ureters vary in their ability to retain the fluid which passes through them. This is due to the fact that there is normally a varying degree of tonus and irritability of these structures. Disease tends to increase or decrease these physiological properties. Tonus and irritability, therefore, have a definite influence upon the extent to which the pelvis and ureter can be visualized by opaque substances excreted by the kidney. The use of the compression bag tends to counteract, to some extent, the influence of these factors.

Surprise has often been expressed regarding the extent to which the kidney

itself is visible in roentgenograms made in connection with intravenous urography. When it is considered that the renal parenchyma is composed almost entirely of blood vessels, glomeruli and tubules, structures intimately concerned in the excretion of the dye, it can readily be appreciated

Fig. 5. An intravenous urogram revealing a calculus in the left ureter and a failure of visualization of the left pelvis and ureter indicating an absence of function. Right side is negative. Compare with Figure 6. Indigo-carmine differential test revealed no function on the left side.

that the amount of the opaque substance in the normal kidney must be considerable in amount and must of necessity tend to accentuate the shadow of this organ. Randall has very aptly termed this shadow a nephrogram. This intensification of the kidney outline is of distinct advantage, since any factor which tends to increase soft tissue differentiation is of definite value in roentgen diagnosis.

One of the distinct advantages of intravenous urography is the fact that to some extent it affords an index to the functional capacity of the kidneys. Much interesting and valuable information regarding renal function may be obtained by this method. However, such interpretation must be made with the utmost conservatism and with the realization that this method gives but a gross conception of function. The determination of renal function is, in most instances, merely a by-product and should not be regarded as a highly important feature of the examination. If functional activity is the question of prime importance then the other functional methods devised for this purpose should be resorted to. However, where it is impossible or inadvisable to perform a differential function test, intravenous urography affords a method for determining the presence or absence of function in one or the other of the kidneys.

One of the common errors in the interpretation of renal function is that made in cases presenting evidence of ureteral obstruction. The accumulation of dye in the renal pelvis as the result of stasis produces a shadow of unusual density. This is likely to be considered an indication of good renal function, whereas the excretory power of the kidney may be, and often is, considerably impaired under such conditions. The density of the pelvic shadow alone is not a reliable guide to the functional state of the kidney. Visualization of the pelvis or ureter, no matter how faintly these structures may appear, is positive proof of the presence of some degree of renal function. Exception to this rule is to be seen in those rare instances where visualization of the pelvis and ureter of a functionless kidney occurs as the result of regurgitation from the bladder of dye excreted by the opposite kidney. In the presence of an increase in the irritability of the pelvis and ureter, as may occur in tuberculosis, the contrast medium may be conveyed to the bladder more rapidly than is normal, resulting in a faint and unsatisfactory outline of these structures. Under such conditions the urogram would not warrant an opinion regarding the excretory ability of the kidney.

It has been repeatedly emphasized, and properly so, that failure of visualization of the kidney pelvis and ureter does not necessarily denote a permanent loss of renal function. We are coming to the realization that transitory inhibitions of function are probably more common than was formerly believed. Persistent absence of dye in the renal pelvis and ureter affords three possibilities: first, either a congenital or acquired absence of the kidney; second, a permanent loss of kidney function, and third, a temporary absence or inhibition of function. The first of these is usually recognized either by the history or by an absence of the kidney shadow. Differentiation between a permanent and temporary loss of function usually cannot be made from the roentgenograms alone. Dependence must be placed upon other functional methods but even these not infrequently fail. This is well illustrated in the following case:

A white male, aged forty-two, complained for eight years of pain in the left side of the back. Disease in the lumbar spine was suspected. A roentgen examination of the spine was negative. There was found, however, a shadow in the left side of the abdomen which was reported as either a calcified mesenteric gland or a ureteral calculus. A uroselectan examination was made (Fig. 5). This revealed the same shadow as previously reported and a failure of visualization of the left pelvis and ureter. These findings were interpreted as a left ureteral calculus and a functionless left kidney. The blood urea nitrogen was somewhat elevated, being 30 mg. per 100 c.c. of blood. A differential function test, by means of indigo-carmine given intravenously, resulted in an appearance of the dye at the right ureteral orifice in 9½ minutes, while none of the dye was obtained from the left side. This was in harmony with the loss of function of the left kidney as found by the uroselectan study. The retrograde method was then employed. The roentgenogram (Fig. 6) revealed a marked dilatation of the pelvis and ureter above the stone. The character of the dilatation indicated the presence of infection and further strengthened the opinion of a complete and permanent loss of renal function. A final diagnosis was made, therefore, of a left ureteral calculus with pyonephrosis. From all clinical studies a nephrectomy was clearly indicated. At operation the stone in the ureter was found and removed. The kidney was enlarged but to inspection and palpation it presented a normal appearance. For this reason a nephrectomy was not done. The patient when seen three months later was perfectly well, and a differential function test showed indigo-carmine at the right orifice in eight minutes and at the left in five. The left kidney had not only recovered its function but was performing even better than the right.

Fig. 6. Retrograde pyelogram, same patient as in Figure 5. Diagnosis, ureteral calculus with pyonephrosis. Nephrectomy indicated. At operation the kidney was found enlarged but was otherwise normal. Not removed. Three months later, left kidney functioning better than the right.

This case presents several important facts. First, there is shown the unreliability at times of the various functional tests and the manner in which they may be erroneously interpreted. The loss of renal function in this patient was of a temporary nature as is so commonly the case in calculi

only partially obstructing a ureter. Secondly, there is emphasized the fact that the final decision as to the proper operative procedure must rest with the surgeon at the time of operation. While laboratory and clinical tests may be of considerable aid, they cannot replace judgment and experience.

Fig. 7. This patient had the left kidney removed several years ago. The dense and unusually well-filled pelvis on the right is indicative of hyperfunction. The enlargement of the pelvis and kidney is the result of compensatory hypertrophy. Film made without compression.

The thought has often been expressed that poor visualization of the upper urinary tract may be the result of hyperfunction of the kidney. It is contended that the rapid excretion of the contrast medium causes it to be expelled immediately into the bladder. We are of the opinion, however, that hyperfunction alone produces an intensification of the pelvic shadow. Without the use of the compression bag adequate filling of the renal pelvis is the exception rather than the rule. Under such conditions we have repeatedly observed that when function is markedly impaired or entirely absent in one kidney, the opposite pelvis is much more completely and satisfactorily visualized than when function is normal or equal on the two sides. This, we believe, is an indication of hyperfunction. When such hyperfunction has existed for a considerable period of time, the pelvis will actually increase in size. This should not be mistaken for a hydronephrosis. It is merely a manifestation of compensatory hypertrophy as can be recognized by the enlargement of the kidney. An example of this type of physiological response to overwork is shown in Figure 7. This patient had his left kidney removed some years ago. In this uroselectan study there is seen a large, unusually dense and well-filled pelvis on the right side. In addition, there will be noted an enlargement of the kidney. Both the kidney and pelvis have increased in size as the result of the extra burden thrown upon them through loss of function of the left kidney.

From the above considerations it is readily seen that the interpretation of renal function from roentgenograms made in connection with intravenous urography calls for a careful and critical analysis of all available data.

In this day of specialization, medical success is largely a matter of teamwork between physicians practising the various specialties. Fortunate indeed is the roentgenologist who has the whole-hearted cooperation of his clinical associates. Daily and weekly conferences with members of the Urological Staff have added materially to the satisfaction and value of our experience with intravenous urography. Much mutual benefit is to be derived from such cooperation. A free interchange of ideas between the urologist and roentgenologist applied to the individual case at hand is certain to result in a greater degree of diagnostic accuracy and to insure the patient the type of medical service to which he is entitled.

Intravenous urography is no longer an experiment. While it has not attained perfection, it is, nevertheless, a practical clinical procedure. Failure to employ it suc-

cessfully is no fault of the method. Careful attention to technical details, an adequate knowledge of the anatomy, physiology and pathology of the urinary system, and a close cooperation with the clinician will render intravenous urography one of the most fascinating, satisfactory and valuable procedures falling within the realm of the roentgenologist.*

* For discussion see page 21.

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UROGRAPHY IN URINARY TRACT ANOMALIES IN INFANTS AND CHILDREN*

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NEW YORK CITY

IN THE order of frequency, the indications for urological examination in juveniles are: pyuria, disturbances of urination, tumor, hematuria and pain. In practically all of these examinations, urography must be resorted to; cystography and pyelography are most often employed; urethrography is a less common procedure.

It is well known, though not generally appreciated, that chronic pyuria (usually mis-diagnosed chronic pyelitis) persists because of urinary stasis. Stasis is most often maintained by obstructions along the urinary tract. In children these obstructions are usually congenital anomalies. Urinary stasis may also result from anomalous position or formation of an organ (ectopic or fused kidney, abnormal ureteral insertion, etc.). We believe that when pyuria persists longer than one month despite intensive medical therapy, a complete urological investigation should be carried out. This was the indication for examination in most of the cases herewith reported.

Preliminary to cystoscopic examination, the following data are obtained: urinalysis (especially for pus, blood and bacteria), blood chemistry (non-protein or urea nitrogen, CO_2), two-hour phenolsulphonphthalein output, a plain roentgenogram of the urinary tract (Figs. 6A and 24) and a cystogram. The latter is obtained by filling the bladder with some radiopaque media (we use 5 per cent sodium iodide). Preferably stereoscopic films are made; sometimes lateral views are helpful.

Following ureteral catheterization and divided renal function tests, we usually make a pyelogram of the suspected side. While we are aware that bilateral pyelography has its attendant dangers, this procedure is often carried out when the renal function is good. It saves reinstrumentation and often reveals unsuspected lesions. When, however, the better kidney is of low function, even unilateral pyelography is hazardous. Sodium iodide (12 per cent) is the radiopaque solution customarily injected, but since its introduction a year ago, we have frequently employed 20 per cent iopax solution. Urograms made by retrograde iopax injection are the most clear cut of any yet obtained.

FIG. 1. Congenital atresia of the meatus in a seven year old boy examined because of pyuria and hematuria. The cystogram shows marked dilatation of the entire urethra but particularly the posterior. The bladder was hypertrophied; ureterovesical reflux has not yet occurred. Meatotomy.

We have used intravenous urography in many children, but the pictures obtained have usually left much to be desired. Retrograde pyelography can be carried out almost as easily as intravenous pyelog-

* Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22-25, 1931.

raphy in children and usually affords far more helpful urograms. It is still our method of choice. In a few instances in which ureteral catheterization could not be performed, intravenous urography has yielded diagnostic clues.

Herewith are presented a series of urograms obtained in patients suffering with one or more of the common urinary tract anomalies.

Congenital atresia of the urethral meatus in the male (Fig. 1). This lesion commonly causes urinary frequency, dysuria or, with ulceration, hematuria. When the stricture is tight, urinary backpressure may cause enormous urethral dilatation behind the obstruction. Meatotomy cures.

Fig. 2. Congenital valvular obstruction of the posterior urethra in a eleven month male admitted to the hospital for constipation. Chronic vesical distention (to the umbilicus) occluded the rectum. Vesical, upper tract and posterior urethral dilatation are notable and regularly occur in these cases. The ureters are thrown in coils. Suprapubic cystotomy drainage, followed one week later by uremic death.

Congenital valves of the posterior urethra are mucosal redundancies usually attached to the verumontanum, extend either forward to the lateral urethral wall or posteriorly into the bladder outlet. When distended they appear similar to cardiac cusps

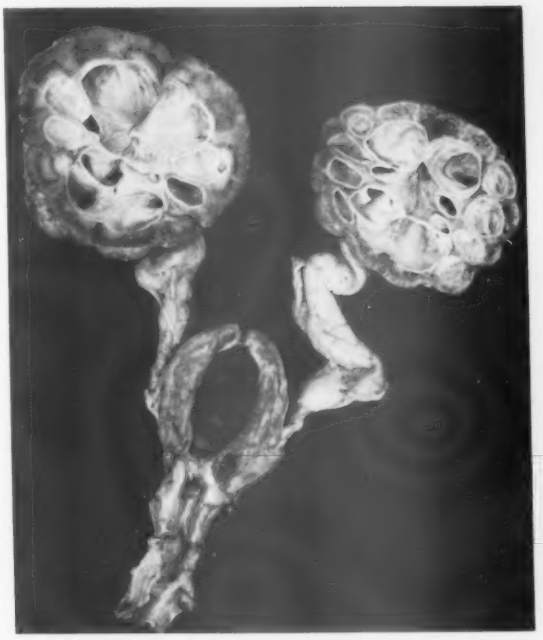


Fig. 3. Autopsy specimen of same case shown in Figure 2. The character of the valves and the upper tract damage are well shown. Hydronephrosis is marked.

Fig. 4. Hypertrophy of the verumontanum in fourteen month old male dead of uremia. No urinary infection existed. The urograms here simulate those of congenital valvular obstruction.

and may cause marked urinary obstruction. Disturbances of urination, upper tract dilatation and renal backpressure destruction result (Figs. 2 and 3).

Congenital contracture of the bladder neck may be due to connective tissue increase in the submucosa or to muscular hypertrophy of the sphincteric ring of the vesical outlet. The symptoms and pathologic changes in the upper tract are identical with those caused by posterior urethral valves. Residual urine is usually present. The urograms show marked bilateral dilatation of the upper urinary channels without, as we so frequently find with valvular obstruction (Fig. 2) and hypertrophy of the verumontanum (Fig. 4), filling of the posterior urethra (Figs. 5 and 6, A and B).

Fig. 5. Congenital contracture of the bladder outlet in two year old male examined because of "chronic pyelitis" of eighteen months' duration. In contrast to valve obstruction urograms, the vesical outlet in contracture is sharply rounded (normal). The upper tract backpressure changes may be extreme. Uretero-vesical reflux commonly exists as shown in the above cystogram; the bladder was filled through a suprapubic tube.

Trigonal curtain obstruction was once observed by us (Figs. 7 and 8). The lesion is a mucosal redundancy of the trigone hanging midway between the ureteral orifices and the bladder outlet and attached laterally to the bladder walls. With each attempt at urination, the curtain flaps forward and obstructs the bladder outlet. Residual urine, upper tract dilatation and infection coexist.

Bladder diverticulum may be congenital (Fig. 9) or acquired. The lesion is most often found in the region of the trigone but in one of our cases involved the bladder dome (Fig. 6).

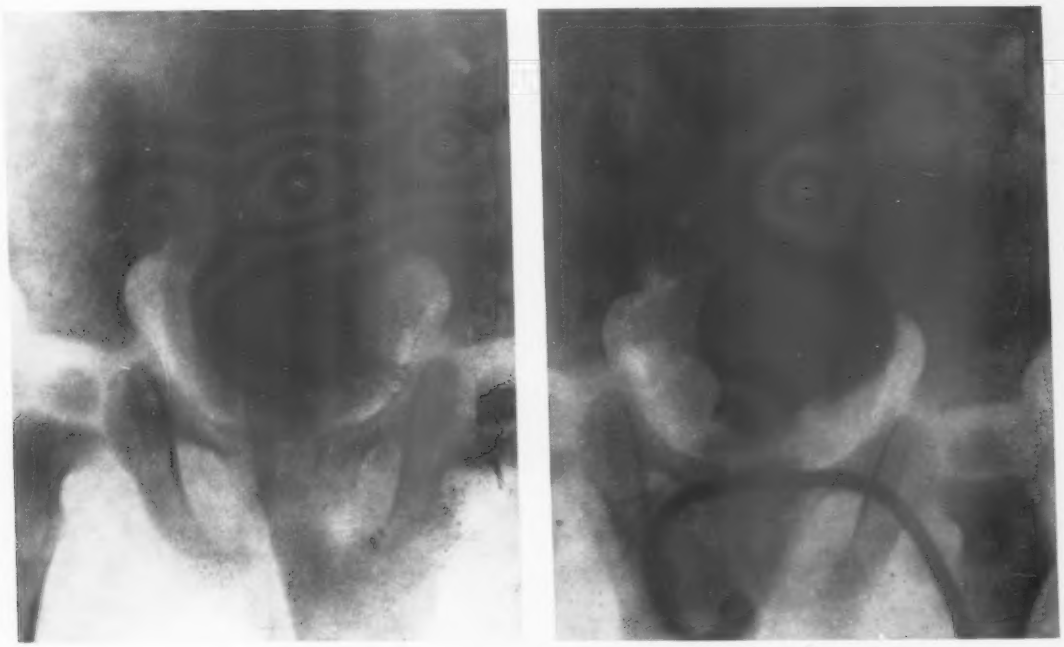
Congenital neuromuscular disease involving chiefly the bladder outlet is occasionally seen. These patients are usually examined because of chronic pyuria or enuresis. The lesion is usually a sphincterospasm of the bladder outlet; the obstruction causes marked backpressure changes in the upper urinary tract (Fig. 10). Occasionally the lesion is secondary to spinal deformity (Fig. 11), especially spina bifida, but in the case here shown, lateral deviation of the sacrum either caused or was associated with sensory and motor loss of the five sacral nerves. Sometimes the vesical lesion is of the paralytic type.

URETERAL ANOMALIES

Absence. This means no kidney (Figs. 12 and 26).

Reduplication. The incidence ratio of unilateral ureteral reduplication is about 1:100; of bilateral reduplication 1:200. Anomalous organs are more prone to disease, especially infection, and it is not unusual to find only one ureter and renal pelvis involved. Reduplication may be complete or partial (Figs. 13 and 15). Junction of the ureter may occur within the bladder wall (Fig. 13).

Congenital ureteral strictures occur in about 1 per cent of all individuals, are most common at the uretero-vesical or ureteropelvic junctions but may exist elsewhere



A B

Fig. 6. A. Large stone in a diverticulum of the bladder dome in a two year old boy with congenital contracture of the bladder outlet. The lesion was cystoscopically observed. B. Cystogram in A. The lower portion of the bladder is poorly shown. Operation refused; uremic death four months later.

and may be multiple as well as bilateral (Figs. 14 and 16). Often the stricture is merely an atresia without connective tissue increase. Sometimes one finds superimposed inflammation.

Abnormal insertion of the ureter into the urethra or vagina may cause the patient to

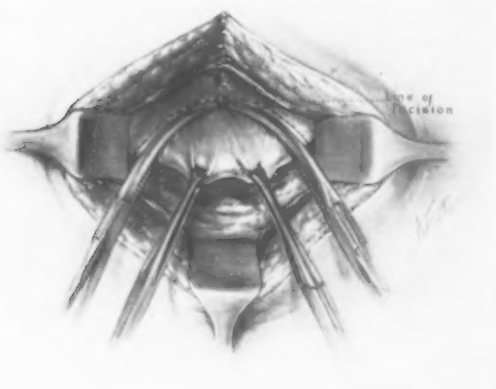


Fig. 7. Trigonal curtain obstruction in thirteen month old female examined because of dysuria and pyuria. Operative findings and method of curtain excision shown above. With each attempt at urination this curtain flopped forward to block the vesical outlet.

Fig. 8. Cystogram of same case shown in Figure 7. A large bladder (4 to 5 ounces residuum) with bilateral ureteral reflux is noteworthy.

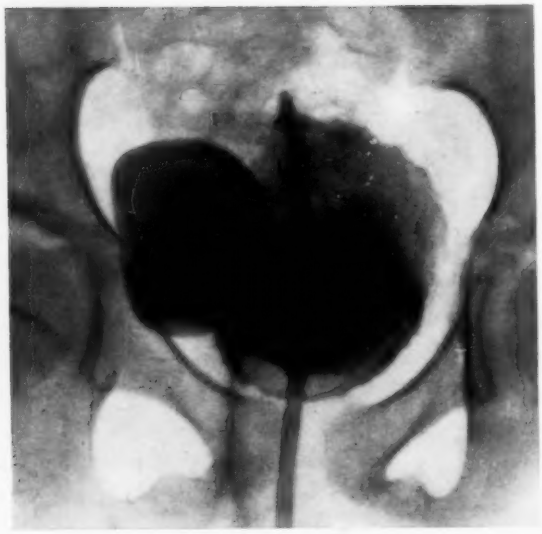


Fig. 9. Diverticulum of the bladder in a ten year old girl examined because of pyuria and "cystitis." A stone, nearly the size of the diverticulum, was removed before this picture was made. Diverticulectomy.

Fig. 10. Neuromuscular vesical disease, so-called cord bladder, in six year old female. Neurologic diagnosis: Myelitis. Residuum 12 ounces. Upper tract damage is extreme. Such a urographic demonstration, intelligently performed, may be accomplished without risk to the patient and sometimes renders cystoscopy unnecessary.

be wet continually. If the urethral opening of the ureter is behind a competent sphincter, retrograde drainage into the bladder will eliminate urinary leakage (Figs. 17 and 18).

Ureteral valves are mucosal redundancies within the ureter which normally disappear by the third month after birth. Occasionally they may persist into adult life (Fig. 19) and may cause obstruction.

Fig. 11. Congenital malformation of sacrum (deviation to right) with sensory and motor loss of the first to fifth sacral nerves in a boy of ten years examined because of "enuresis." The bladder shows an irregular pyriform outline with sacculation and ureteral reflux. The funnel-shaped vesical outlet is due to paralysis of the internal sphincter.

Aberrant vessels frequently obstruct the ureter; those of greatest clinical importance pass from the lower renal pole to the great vessels. Hydronephrosis and pyuria usually coexist in these cases (Figs. 20 and 21). By aberrant vascularization in the pelvis the lower end of the ureter may be obstructed. From urograms in 3 cases we have diagnosed this condition in children; but one of these came to operation; the obstructing vessels were resected.

RENAL ANOMALIES

Bilateral absence means an unviable monster.

Unilateral agenesis occurs once in about 1,600 individuals (Figs. 12 and 26) and because of the added load the solitary kidney must carry, this organ is somewhat more prone to disease than a normal kidney having a normal mate.

Unilateral hypoplasia or dwarfism is of the same clinical importance as unilateral agenesis. Frequently these anomalous kidneys are not more than 1 or 2 cm. in diameter and architecturally a fibrolipomatous mass (Fig. 22). The small hypoplastic organ adds little or none to the total urinary output demands. The condition is to be differentiated from secondary renal degeneration due to inflammation or infection.

FIG. 12. Solitary kidney (congenital unilateral renal agenesis) in six year old girl examined because of a freely movable right abdominal mass. The kidney is dystopic and can be moved to almost any portion of the lower abdomen. The urogram also suggests uretero-vesical junction atresia although the catheter encountered no obstruction. Trigonal hemiatrophy and repeated chromocystoscopy confirmed the diagnosis.

FIG. 13. Ureteral reduplication in a girl of five years examined because of "chronic pyelitis." The ureters join within the bladder wall; there is but one orifice. Catheter maneuver 3 mm. within the orifice directs the catheterization of the separate ureters. Marked ureteral dilatation.

Renal reduplication is always associated with ureteral reduplication; each kidney pelvis has its own ureter stalk. These stalks may fuse before entering the bladder. In 3 cases of double kidney we have found hemipyonephrosis; uretero-heminephrectomy was successfully performed in 2, nephrectomy in 1 (Figs. 15 and 18).

Renal ectopy is dependent upon anomalous vasculo-renal development. It would appear that these dystopic organs are held in their anomalous position by a pelvic or lower abdominal vascular attachment which failed to disappear at the proper time in embryonic development. This anomalous vascular derivation (from the iliacs, hypogastrics, lower aorta and so

FIG. 14. Congenital uretero-vesical junction stricture in female aged two months. This is the lower half of a double kidney. Hydropyonephrosis was found.

FIG. 15. Uretero-pelvic reduplication in same case shown in Figure 14. The upper fetal pelvis is surrounded by good functioning parenchyma. Uretero-heminephrectomy with removal of the lower renal half successfully performed at the age of twenty-eight months.

FIG. 16. Bilateral congenital uretero-vesical junction stricture in male aged seven months. Extreme upper tract damage.

FIG. 17. "Cystogram" in female aged five months examined because of persistent pyuria. The catheter entered an ectopic ureteral opening on the floor of the mid-urethra; the ureter drained the pyonephrotic upper half of a double kidney (Fig. 18).

FIG. 18. Pyelogram in same case shown in Figure 17. Normal left lower pelvis with strip of parenchyma separating it from pyonephrotic pelvis above. Uretero-heminephrectomy successfully performed at the age of six months.

FIG. 19. Congenital ureteral valves in boy aged seventeen. The valves were found at autopsy to be a persistence of the fetal ureteral mucosal redundancy so commonly noted in the newborn.

forth) serves to differentiate true renal ectopy from simple nephroptosis.

Polycystic disease seldom manifests itself in infancy or childhood. Urograms in these cases closely simulate those of adults with this disease (Fig. 23).

Renal tumors sometimes are congenital but do not fall within the type of abnormal

FIG. 20. Aberrant renal polar vessel obstruction of the ureter in a girl aged five examined because of chronic pyuria and abdominal pain. The hydronephrotic destroyed kidney is demarcated from the upper ureter by an obliquely upward shadow which indicates the course of the obstructing vessel. Because of vascular compression there is no pyelographic medium at this point. Diagnosis confirmed at operation. Nephrectomy.

development discussed here. The urographic diagnosis of renal tumor in infants is seldom difficult. Pelvic distortion, displacement, elongation or obliteration are commonly observed.

Anomalies occur in the urinary tract more often than elsewhere. For this reason an anomalous condition in another body system strongly suggests the likelihood of an associated urogenital anomaly. We have

FIG. 21. Aberrant vessel obstruction of the kidney in a boy aged eleven. Operative specimen. An enormous hydronephrosis existed with total renal destruction. The pyelogram here was somewhat similar to that in Figure 20.

FIG. 22. Renal hypoplasia in a girl aged seven. The marked difference in pelvic contours and capacities is notable. The dwarf pelvis is of the fetal type.

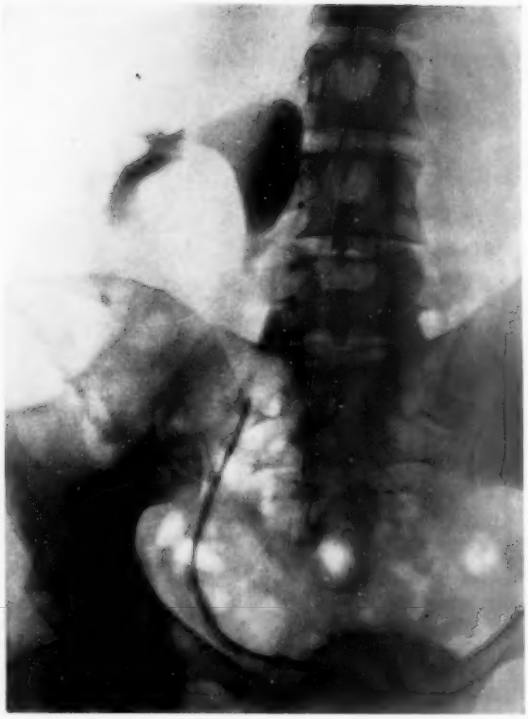


FIG. 23. Polycystic renal disease in young adult. This pyelogram shows the marked pelvic distortion so commonly produced by this lesion.

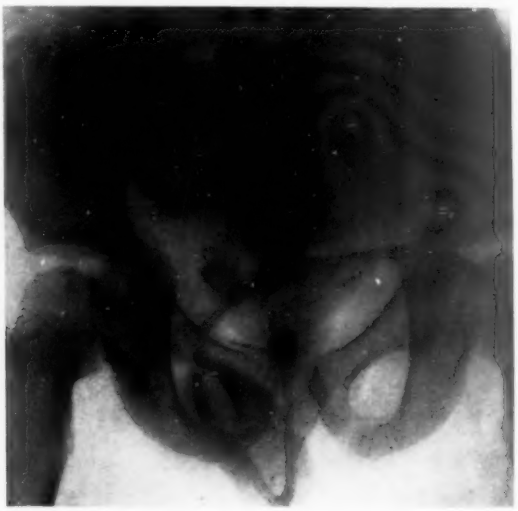


FIG. 24. Two urethral stones in male aged five with congenital urethral stricture and urethro-rectal fistula, congenital stricture of the rectum, megalocolon and congenital solitary kidney. One stone has been pushed back into bladder (by cystoscope). These clinical findings were confirmed at autopsy.

observed several such instances. Recently we examined a five year old boy with pyuria (Figs. 24, 25 and 26). We found urethro-rectal fistula, two stones in the posterior urethra, a small, contracted, distorted bladder, a solitary right kidney, a congenital stricture of the rectum and a megalocolon 6 inches in diameter. The boy subsequently died of measles; autopsy confirmed the clinical findings.

SUMMARY

In juveniles, anomalous urinary tract developments are commonly the etiologic factor when persistent infection exists. By urography nearly all of these anomalies may be demonstrated and diagnosed. The roentgenographic diagnostic criteria are identical with those employed when the patient is an adult. Urograms of the common anomalies are presented and forcefully demonstrate the impossibility of accurate urologic diagnosis without urography, especially in infants and children.

Fig. 25. Cystogram in same case shown in Figure 24. The bladder is small and laterally displaced by the enormous rectum. The urethra, particularly the deep bulbous and posterior, is widely dilated. Sodium iodide reflux into the left seminal vesical and vas deferens is noteworthy.

Fig. 26. Pyelogram in same case shown in Figure 24. The solitary kidney pelvis is outlined. A catheter was passed into the rectum through the urethra (urethro-rectal fistula?) and the lower bowel filled with sodium iodide solution. At autopsy the rectum was found to be 6 inches in diameter.

DISCUSSION OF PAPERS BY DRS. KORNBLUM AND CAMPBELL

Dr. M. Swick, New York City. In the evaluation of intravenous urography it is very essential to consider it as only one aid in urologic diagnosis. Accordingly, the method is not without its limitations and cannot therefore entirely supplant cystoscopy and retrograde pyelography. As a diagnostic measure it must be considered in conjunction with the history, physical and laboratory findings.

Because intravenous urography is dependent upon the mechanism of excretion, one must of necessity discuss renal function as it pertains to that method. For purposes of visualization a certain concentration of the excreted radiopaque element (in the case of uroselectan), the iodine component, is necessary. That concentration in turn depends upon renal and extrarenal factors influencing renal excretion. Broadly

speaking, therefore, one can state that the question of visualization, poor or no visualization is intimately bound up with that of renal function. With this general viewpoint in mind and based on experiences with this procedure, the following aspects concerning visualization and renal function are presented to illustrate essential principles necessary in the evaluation and interpretation of this method:

1. Instances of poor or no visualization, either bilateral or unilateral, in the face of normal renal function, have been encountered. These results are believed in part to be of faulty technical origin.

2. Moreover, it is important to bear in mind that the function of the kidney may be temporarily inhibited and that the mere non-visualization at a given examination does not necessarily denote permanent renal damage. High occluding ureteral stones or trauma incidental to pyelography have furnished such examples.

3. In cases of hydronephrosis intense visualization has been observed, despite the presence of only little intact renal tissue. Therefore, the intensity of roentgenologic visualization is no quantitative criterion nor one for determining the type of therapeutic procedure.

4. The non-visualization of a conducting system secondary to the anatomical and functional derangement of the kidney parenchyma is in itself of diagnostic value as a means of localization. Such findings have been found invaluable in cases of profuse hematuria, and where for mechanical reasons or in the presence of infections, cystoscopy and retrograde pyelography could not be carried out.

Finally, as Dr. Kornblum so aptly pointed out, the use of the compression bag is very helpful in obtaining readable and suitably diagnostic urograms. Without its use incomplete, indistinct, and faint shadows are often observed which may lead to an erroneous impression that one is dealing with a filling defect based upon a renal neoplasm or tuberculosis. We have failed to observe any artificial abnormal dilatation of the upper urinary tract as a result of its application, so long as the normal tone of the calyces, pelvis, and ureter exists.

In closing, permit me to express my respects to Dr. Kornblum for his thoroughly enlightening and scientific paper.

DR. ALEXANDER RANDALL, Philadelphia. In duscussing Dr. Kornblum's and Dr. Campbell's papers, let me say that I have had the pleasure of working with Dr. Kornblum and I can back up exactly what he said in his own words. To us it has become "one of the most fascinating" studies in our individual departmental work. When you stop to realize that by this one method renal anatomy is brought to your vision, and not only anatomy, but renal physiology is also depicted, and not only anatomy and physiology, but pathology is likewise visualized, one should say that he has a very valuable diagnostic adjunct.

Then in addition to that informative triad, we can add often the clinical diagnosis and even further than that in a great many cases the direct therapeutic indications. This is such an innovation one has to stop and take stock of where we were a short eighteen months ago. I dare say that if any of you on your return go to the most outstanding physiologist in your community and ask him whether the renal pelvis is normally empty or filled, unless he is abreast of this work, his answer will be "empty," when today we know it is normally filled. If you ask him where the recognized ureteral peristaltic wave originates, again I think you will have him stumped, for unless he is abreast of this method of investigation, he will not know that it originates high in the papillary-calyceal angle. Next try him on pelvic systole and diastole to complete the impression that you are stark mad; or ask him whether the ureter as an organ is fairly fixed or has a high degree of motility, and then tell him of Dr. Kornblum's presentation and studies.

These are but a few of the outstanding features that this new diagnostic method has brought into our knowledge, touching, as I say, on anatomy, physiology, pathology, clinical diagnosis, and, finally, actual therapeutic indications. That is what has made it such a fascinating study.

Dr. Kornblum has very wisely restricted his remarks today to technique and interpretation. For a long while we felt that it was wrong to disturb the normal physiology, or probably the pathological physiology, of the urinary tract while taking its picture. We had to abolish from our minds all the fallacies of retrograde pyelography. You realize, of course, that retrograde pyelography has been one of the most brilliant adjuncts to diagnosis, but you must realize also, that technically it was the most unphysiological process that could be conceived of. Therefore, when we started with intravenous pyelography we had to revamp much that we had learned from ordinary retrograde pye-

lography. We felt at first it was wrong to disturb the anatomy and physiology of the urinary tract when under investiga ion, and to obtain pictures devoid of any external hindrances or artefacts.

Dr. Swick has accentuated further what Dr. Kornblum said that after all, although we do want to read and should read that undisturbed physiological activity, we also want to get clearly outlined a visualization of the renal pelves for very slight or early lesions. For that reason Dr. Kornblum's technique has been altered (and I want to accentuate that point, because it is important) so that *some* of the pictures, *not all*, are taken under a bag compression to get a clear outline of the pelvic contour, but other pictures simultaneously, or practically simultaneously, are taken without compression in order to get the other valuable assets that the method allows.

It is interesting to see how this method has changed our working routine because it has very definitely eliminated a lot of instrumentation and in simple problems the need for an investigation of renal function. For instance, a plate depicts a suspicious shadow Intravenous urography shows it to be a ureteral calculus blocking the canal. In the past we wouldn't think of operating on that patient until we had cystoscoped him and done some form of functional investigation to determine the safety of the procedure by demonstrating that he had an opposite normally functioning kidney. This intravenous urography now does for us.

A month ago a man walked into my office late on Monday afternoon, presenting a plate which had been taken by a very competent man in a neighboring smaller town. This plate showed a shadow typical of a low left ureteral calculus. The physician there had cystoscoped him and in his letter to me said the man had so much irritation and edema about that orifice he could not enter a catheter, that he had given him an injection of indigo-carmine, and although the opposite right side had functioned promptly, nothing had come from the left. He felt he had a completely blocked ureter that demanded immediate surgery.

That man entered the hospital after sundown Monday. He was prepared and intravenous urography was done the next morning. At twelve o'clock those plates were read and were highly suggestive of unilateral tuberculosis and not stone. The shadow as depicted in the flat plate was a centimeter outside the ureteral line. By four o'clock that afternoon the laboratory reported large quantities of acid-fast bacilli. The following morning a tuberculous kidney was removed.

Inside of twenty-two hours, without any cystoscopic investigation (unless we can include what his physician at home had done), a complete urinary tract examination and diagnosis were made and confirmed by the laboratory. This could not possibly have been accomplished two years ago by the methods then in vogue.

These are simply two illustrative cases of how this method has improved our approach to these cases and their handling.

This is but a step towards further development. I haven't the slightest doubt that in a very short time we will have other drugs with greater value, not only in producing better shadows possibly, but drugs which will give us visualization of the actual kidney itself. Those who have used the method realize that you do get, of course, a greater intensification of the renal shadow and ofttimes very brilliant pictures of the renal outline. It is but a step chemically to produce a drug which will give us true pictures of the kidney. We can call them, if you wish, nephrograms, and what I look forward to are pictures which will depict for us functioning portions of the kidney and give filling defects of the portions of a kidney which are undergoing pathological processes and, therefore, non-functioning. We will get in all probability through your assistance in a short while brilliant early diagnoses of renal lesions, such as tumor, abscess and cyst.

The second point which Dr. Kornblum brought out was the question of interpretation. We have felt, and through his hearty cooperation, experienced, a close teamwork between the roentgen interpretation on the one hand, and the clinical interpretation from the urological point of view, on the other. I do not think it is fair or right to ask the urologist to interpret a roentgen plate unless he has had vast experience equivalent to yours, and I do not think it is right or fair to allow yourselves to attempt to evaluate clinical conditions from the roentgen point of view only. It has come out in our weekly conference time and again where the evaluation of these two points of view have been necessary to gain the proper interpretation and indications for the handling of the individual case.

One thing we early learned was that the

stone obstructing the ureter which showed above it a non-functioning kidney from a completely blocked ureter was in need of immediate surgery. We know clinically that such a kidney can lie dormant and symptomless for an indefinite period of time, gradually undergoing disuse atrophy, but if infection is added to that kidney, its life is short.

On the other hand, a stone only partially blocking, where the plate shows function in that kidney, and passage of the urine past the stone, can be safely handled on palliative cystoscopic methods with the idea of possibly getting the stone out without imperative operation. Such problems have been evaluated by both sides of this departmental work and it has been of immense value.

There are two factors which I wish to mention in closing, that are unsuspected dangers that enter into this interpretive work: first, that unnecessary operations will be performed on insufficient grounds, and second (possibly the more to be regretted), that early diagnosis in those serious conditions, such as malignancies and tuberculosis, will be missed on insufficient interpretation. Those are the two things that you must watch.

I have nothing but the greatest admiration for Dr. Campbell's work. He has had an experience that is to be envied, and he has done a yeoman's duty in bringing to the attention not only of the roentgenologists (they didn't need it) but of the profession at large and the pediatrician in particular, the knowledge that children can have in their urinary tracts any form of pathology that is seen in the adult. He has brought into it a technique that is most admirable, but he has yet to accomplish the hardest problem of all, and that is to convince the pediatrician at large that such things exist.

Dr. G. F. Haenisch, Hamburg, Germany. It was not my intention to enter this discussion after hearing such complete reports, and I have nothing special to say. I only want to emphasize what some of the speakers have already said. I think that intravenous urography is a great step forward, but it does not take the place of retrograde urography. It only makes the possibility of diagnostic work much wider and broader.

I quite agree with what Dr. Randall said, that a roentgenologist who is not absolutely familiar with the clinical data is not able to make a diagnosis from his intravenous pyelography films, nor should the clinician be allowed to think that he can get a diagnosis out of the film if he is not absolutely familiar with the roentgenological aspects.

I did not quite agree with what was said about compression in intravenous urography. I did quite a lot of that, but I discontinued it some time ago. I think we must let each of the two methods have its place The intravenous method is more the biological one to show the function of the kidney, of the pelvis, and so on, and the retrograde method is the one to show anatomical changes. If I cannot visualize the pelvis with the intravenous method, I wait at least twenty-four hours and take another film—first, after six hours, twelve hours, and then another one even after twenty-four hours, and quite frequently the pelvis will fill at the end for some cause or other that may be there.

If I don't get the filling of the pelvis, then I follow up the case with retrograde pyelography because that is, to my idea, the better method of showing anatomical changes.

I do not rely upon the intravenous method, for instance, in diagnosis of tumors or any defects of the pelvis. I prefer the other method; of course only in cases where it can be done. Otherwise we have to use the compression bag. I don't think you can compress both ureters equally, and so there is always some possibility of error.

I see a great benefit in the intravenous method in cases where there are two ureters or four, but only two openings in the bladder, especially in cases where you can, as I succeeded in doing in a couple of cases, prove that one-half of the kidney is diseased and there is a possibility of having that half kidney taken out and the other part remain. In those two cases it was the upper half of the kidney that was found sound and could be left in.

Dr. Kornblum spoke about the annoyance we find with gas. I think all of us have had much trouble with that, and all ways of doing away with it are more or less unsatisfactory. His method, which he published some time ago, to screen the patient first, I think is very apt to help. We do that, too. Even if you do that, however, and wait until the next day, the gas may still be there.

We tried enemas but they do not remove the gas. I would like to ask Dr. Kornblum if he has not noticed that even beginning with a case where gas is not present, it will appear when you go on examining the case and do the second or third or fourth film. Then the gas is

being formed and you can't do anything about it.

In ureteral stones, I think we have profited by using the intravenous method. Upon examining a case you may find a small ureteral stone and you might have said in previous days, "Well, that stone is so small we can wait and see whether it will come out by itself." You didn't know whether to use all sorts of clinical procedures to remove it or to wait. Nowadays I think it is very pleasant to have the opportunity to see whether that stone needs quick removal or not, whether it affects the kidney very much or not.

In doing the intravenous method, you have all noticed that in some cases a small ureteral stone will affect the kidney so much that it won't work, that there is a reflex anuria. This might indicate the necessity for removing the stone.

In other cases, the retrograde method did not allow us any aspect of the pelvis or the calyces because the catheter could not be pushed upward far enough and the dye would not go up high enough or as far up as the little ureter stone. Now you have cases where you can get a good view of the pelvis and the calyces above the stone in the ureter. I think that is a step forward, too.

In former years the normal anatomy of the ureter has been discussed. When retrograde urography alone was used we thought the ureter had a certain curve which was normal to it. Intravenous urography, I think, showed us that that was a mistake and this S-shaped curve was only made by the catheter. We now know that the normal ureter goes in all sorts of little curves and kinks which change all the time, and if you follow up a set of films taken just one or two hours or even ten minutes apart, you will see that these kinks are not at all fixed, that they change all the time, that the ureter moves about, far more than we thought before this method was devised.

Dr. William H. Stewart, New York City. I can't understand why all this excitement about compression. I have used compression for years in all sorts of examinations, urinary tract, gallbladder, etc. I use it to aid me in obtaining technical results. Anyone who imagines he can produce an obstruction to the ureter by external abdominal pressure sufficient to cause a backing up of urine in the kidney in any patient who weighs over 150 pounds is misled. If the patient has unusually dilated ureters and is quite thin it is possible. What they do is to produce fixation—fixation of the diaphragm, fixation of all the internal organs that are in the abdominal cavity. We all know that there is a certain amount of movement present in the abdomen which is involuntary. I have noticed it in gallbladder work many, many times, and compression aids in controlling it. I have also found that rubber bags filled with air and used with compression accentuates the shadows. I also question whether abdominal compression on the average individual changes the course or the appearance of the ureter in any way and doubt that I can produce or relieve kinks or change the physiological appearance by this method except in very unusual cases.

The next question is, how can we avoid excessive intestinal gas in these cases? Dr. Kornblum's idea of a preliminary examination is a good one but I agree with Dr. Haenisch that you may have an intestine absolutely free of gas before the administration of the dye but after it the gas appears very rapidly, sufficient to interfere with the examination. This can be avoided to a considerable extent by using drugs which render the urine opaque to the rays almost immediately, thus you obtain your initial film of the urinary tract before intestinal gas has had time to form. This roentgenogram taken within five minutes after the injection is often the most satisfactory of the entire series.

Dr. David R. Bowen, Philadelphia. Just a word, the amount of gas is directly proportionate to the length of starvation.

Dr. Kornblum (closing). I was very glad to hear Dr. Swick and Dr. Haenisch both emphasize the fact that intravenous urography is not a competitive examination to the retrograde method. That is a prevalent idea which is a mistaken one. You should not get the impression that intravenous urography is going to supplant the retrograde method, certainly not in its present stage of development.

Dr. Randall has very forcefully brought out the importance of the physiology that is being called to our attention by means of intravenous urography. This is an etremely important aspect of the subject and one which is especially important to roentgenologists. I think roentgenologists in general should be more physiologists than we are today. The more we know of physiology and the more we know of pathology, the better roentgenologists we are going to be. Anything of this kind, in which we must know

physiology, is going to help us tremendously.

I was very interested in the remarks that have been made about gas, and in general I agree with these. What Dr. Bowen has said on the question of starvation I think is very important. I have always insisted that our urologic cases be examined the first thing in the morning, as early as possible in the morning, because I believe if they are permitted to go any length of time without food, they invariably fill up with gas. We also give them a light breakfast. I think doing away with the breakfast, as is so commonly practised, is not a good procedure because I believe a light breakfast in the morning will stimulate peristaltic activity and get rid of some of the gas. Of course, we all know that in certain individuals it is simply impossible to get rid of the gas, so that there will be a certain group in which we will fail, even though we do fluoroscope the patients.

The fact that patients do fill up with gas was very forcibly brought out by Dr. Swick's first case he showed. If you will remember, between the two slides there was an interval of four hours. I don't know whether you noticed or not, but the second film showed an enormous amount of gas where the first one showed very little. That is proof positive in my own mind that the gas does accumulate in the waiting interval. If we can get good films early and, as Dr. Stewart has brought out, use a drug which gives us an early visualization, the better it is. Formerly it was the practice to continue these examinations for an hour and fifteen minutes or two hours. We have cut that down to forty-five minutes, so that our examinations are all complete in that time. You can do it even in less time than that if you care to.

Dr. Stewart has made some very apt remarks concerning compression. I am sorry I can't agree with him in all of his details, but some of his facts I am certain are absolutely true. I still believe that we do produce obstruction in the ureters and we do produce distention of the pelvis and the ureters by compression and not by immobilization alone.

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INFLUENCE OF URETERAL STONES ON INTRAVENOUS UROGRAMS

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WHEN uroselectan (iopax) appeared we attempted to use it to visualize ureteral stones which were not opaque to the roentgen ray. We expected, because of the stasis, to have the best picture on the affected side, and that the stone could be easily located due to the well-filled kidney pelvis and ureter (accompanied by a variable degree of ureterectasis) above the obstruction. Instead, we routinely found that while both kidneys were increased in density, on the unaffected side there was a well-filled pelvis and ureter due to normal excretion of the drug and on the affected side, though the kidney shadow was often denser, there was not a trace of the drug in the pelvis or ureter. Our findings have been so constant that in the cases of suspected ureteral stone we routinely use intravenous pyelography and if the drug is eliminated promptly from both kidneys, we assume the absence of ureteral stone.

Temporary inhibition of the secretory function of the kidneys has long been recognized. It has usually been noted following urethral or ureteral instrumentation. We have seen anuria of three or four days' duration follow simple urethral instrumentation, such as the passage of a sound or cystoscope, and the past unpopularity of bilateral pyelograms in some clinics was undoubtedly due to this phenomenon, which was incorrectly interpreted. Ureteral instrumentation is known sometimes to cause a temporary inhibition of kidney function and it is quite probable that a stone capable of causing kidney colic would have the same effect. It has been a common experience to find only a trace of phenolsulphonphthalein, or indigo carmine, in the urine from the affected side and yet at operation the kidney substance would appear normal. Probably this reflex inhibition from the ureteral irritation acts to protect the kidney from an early hydronephrosis. At any rate, the excretion of the drug is inhibited by a reflex from the affected ureter. The drug is present in the tissue of both kidneys since they increase in density after the uroselectan (iopax), skiodan or neoiopax is injected intravenously, but it is not visualized in the renal pelvis or ureter of the affected side. Undoubtedly the normal and inhibited kidneys receive the same amount of blood and hence an equal amount of pyelographic medium. This must be concentrated before it will cast a roentgen shadow; therefore its mere presence in the blood is not sufficient. The drug is eliminated through the glomeruli, but during the stage of inhibition does not reach the kidney pelvis or calyces, hence must be concentrated at the elimination point between the glomeruli and the collecting tubules. It is quite probable that this inhibition is not complete for any considerable length of time, but the amount of the intravenous drug that passes through is too small to cast a shadow in most cases. Recently, in testing this theory, it was noted in one case that the earlier roentgenograms showed increased density of both kidneys with a well-filled pelvis and ureter on the unaffected side and none on the side of the stone, but one and a half hours later, when there was no picture on the normal side, there appeared a faint shadow of the pelvis on the affected side.

In the chronic cases, where the ureteral stone has long been present, the kidney has overcome its inhibition and a hydronephrotic pelvis is usually outlined. If there is a temporary kidney block, in such a case the kidney shadow will be dense even though the dilated pelvis is not outlined.

Three characteristic cases selected from

FIG. 1. Case 1. Intravenous neo-iopax. Normal right kidney and ureter. Stone 0.6 cm. in diameter in lower left ureter. Shadow of left kidney denser than right, apparently none of the medium has been excreted on that side.

our series, illustrating errors in interpretation of intravenous pyelograms, due to temporary inhibition, are reported in brief.

CASE 1. *Sudden blocking of ureter with stone followed by temporary anuria of affected side and accompanied by kidney colic:* (No. 2206) D. McD., aged forty-eight, married, contractor, referred by Dr. Otto Pflueger. This patient's history is unimportant except that he has had malaria many times, but no attacks in the past ten years; has had ten attacks of "pneumonia," generally complicated with pleurisy; the last was five years ago. At that time he was in the hospital seven months as he had at the same time an appendectomy and tonsillectomy, and treatment for chancre that appeared during his hospitalization. He has had a deviated septum for thirty-five years and also badly infected sinuses. His initial gonorrhea was acquired at sixteen, and there have been numerous subsequent infections.

Six months ago he had his first attack of kidney colic, in Sacramento, and after examination by a urologist was reported free from stone. Two months ago, following a similar attack, a roentgenologist in Stockton found no evidence of stone and the same report was made one month later when he had an attack in Monterey.

The present illness began in the night of October 24, 1931. Intravenous pyelography was done October 26 (Fig. 1). The films showed a normal kidney and ureter on the right side. The left kidney was increased in density but no filling of the pelvis or ureter could be demonstrated. A small stone was seen in the region of the lower end of the left ureter. The following morning a complete kidney investigation was carried out. After two small strictures in the anterior urethra had been dilated, a 26 F. Brown-Buerger posterior cystoscope was passed. A No. 6 ureteral catheter entered the right kidney with ease, while it required some manipula-

FIG. 2. Case 1. Retrograde pyelogram made following day indicates little or no destruction of left kidney.

tion for a similar catheter to pass by the obstructing stone low down in the left ureter. There was a free flow of urine from the right kidney and after a considerable amount of thick pus was aspirated from the left there was a small flow of urine. The cultures showed staphylococcus on both sides. Phthalein was injected intravenously and appeared on the right in three minutes and on the left in seven minutes. At the end of twenty minutes 24 per cent appeared on the right and 2 per cent on the left. Pyelograms were then made (Fig. 2), after which, with a Howard stone remover the obstruction was easily dislodged. Two days later a skiodan injection showed that the left kidney was functioning well (Fig. 3). At the present time (according to the phenolsulphonphthalein test) the two kidneys have an equal and normal function.

Comment: Nature, by cutting down temporarily the function, prevented a hydronephrosis of the blocked left kidney. If a roentgenogram had been made in this case at the end of two hours after injection on the first day there might have been a shadow of the pelvis on the affected side, since there was a slight function.

Fig. 3. Case 1. Intravenous skiodan three days after Figure 1 shows that function is returning in left kidney. (A different intravenous preparation was used for sake of comparison.)

Fig. 4. Case II. On left side stone, in contact with catheter, prevented entrance of pyelographic medium; two stones in right kidney, one at ureteropelvic juncture apparently interfered with filling of pelvis.

Case II. *Bilateral renal lithiasis with almost complete blocking of one ureter by stone:* (No. 2038) I.A., aged fifty, married, merchant, referred by Dr. R. P. Giovannetti because of hematuria, stones in the urine, nocturia and pelvic pain. About four years ago he voided a calculus and since that time has passed about 400 stones. Blood has been present only at rare intervals, and there have been no other urinary symptoms except nocturia for the past two years.

January 19, 1931, Cystoscopy: From the left ureteral orifice was expelled at regular intervals a stream of pus. A No. 7 catheter passed with ease to the right kidney but on the left a stone

Fig. 5. Case II. Intravenous uroselectan made three days after stone was removed from left ureter. Left kidney enlarged and shows concentration of uroselectan in cortex but no excretion. On the right side there is a hydronephrosis and the two stones show clearly.

5 cm. from the orifice prevented the passage of a catheter (Fig. 4). The urine from the right contained staphylococcus on culture. Phthalein was injected intravenously and appeared on the right side in nine minutes; 3 per cent in the first fifteen minutes and 3.5 per cent in the second fifteen minutes. The transvesical collection (assumed to be from the left side) was 1.5 per cent. The blood non-protein nitrogen was 48 mg. per cent.

January 23, 1931, Cystoscopy: No. 6 bougie, after some manipulation, passed the stone in the left ureter, then a Howard stone remover was inserted and the obstructing calculus, 8 mm. in diameter, was removed.

January 26, 1931, uroselectan was injected intravenously (Fig. 5). Both kidneys were well outlined. The right was enlarged and there was a hydronephrotic pelvis containing two stones; on the left the kidney was much larger and denser, but there was no evidence of the solution in the pelvis and no stones. Apparently the uroselectan was being concentrated in the kidney substance and little passing through the glomeruli. Non-protein nitrogen 67 mg. per cent; creatinine 2 mg. per cent.

January 29, 1931, Total Phthalein (intravenous): First hour, 40 per cent; second hour, 25 per cent. Non-protein nitrogen 34 mg. per cent.

February 2, 1931, Cystoscopy: A No. 7 catheter passed to the right and there was free flow of urine. On the left side the catheter met an obstructing stricture in mid ureter. In order to try a large bougie on the left, it was necessary to withdraw the catheter from the right and change instruments. Apparently when the catheter was withdrawn it pulled the ball valve stone down and blocked the ureteropelvic juncture. After the left stricture had been dilated, bilateral retrograde pyelography was attempted. There was a complete block on the right and a hydronephrosis and hydroureter on the left, with a stricture in the middle (Fig. 6). The urine culture from the left contained

Fig. 6. Case II. Right side blocked and what was presumed to be a dead left kidney has taken on all the function.

staphylococcus. Phthalein was injected intravenously and appeared on the left in five minutes, 14 per cent being excreted during the first fifteen minutes and 11 per cent on the second fifteen minutes.

February 9, 1931, Total Phthalein: First hour, 52 per cent; second hour, 22 per cent.

February 11, 1931, right pyelotomy and nephrotomy for removal of stones.

Comment: The large hydronephrosis on the left was the result of the chronic infection and the occurrence of multiple stones in the past, while the inhibition of secretion of the uroselectan was due to the temporary reflex from the obstructing stone. When the stone had been removed and the opposite side became completely obstructed, this presumably worthless "dead kidney" immediately became 100 per cent efficient.

Case III. *Temporary inhibition of kidney due to ureteral catheter followed by unusual intravenous pyelogram with resultant probably incorrect diagnosis of adrenal tumor:* (No. 2168)

Fig. 7. Case III. Left kidney suspected to be seat of adrenal tumor.

Fig. 8. Case III. Intravenous urogram, skiodan. Spider-like deformity of left renal tumor.

Miss A.H., aged twenty-two, single, referred by Dr. Earnest Dozier, of Redding, California. Patient's history was unimportant up to four years ago. While attending normal school her entire disposition changed. Her roommate reported, because of her queer actions, that she was losing her mind, and so the authorities sent her home. There was a sudden increase in libido which was more noticeable as she had been of the demure type. She developed vesical frequency every hour and incontinence (has worn a pad for three months), nocturia six times, irregular menstruation and an increase in the growth of hair so that she found it necessary to shave her entire body once a week. She had consulted numerous physicians and a psychiatric examination made at Napa State Hospital was negative.

September 8, 1931, Cystoscopy (sodium amytal, nupercain and morphine anesthesia): A 26 F. Brown-Buerger anterior cystoscope passed with ease. Bladder capacity 600 c.c. (She had previously been diagnosed as having a contracted bladder.) Catheters were passed

easily to both kidneys. The urine from the left kidney was sterile; the culture from the right grew Gram-negative and Gram-positive bacilli, as did the bladder urine. Phthalein was injected intravenously and appeared on the right in three minutes; 20 per cent in the first fifteen minutes and 8 per cent in the second fifteen minutes. On the left side a trace appeared in twelve minutes, and only 2 per cent in the second fifteen minutes.

FIG. 9. Case III. Pyelogram made two weeks later showed normal left kidney pelvis. (Courtesy of Dr. Robert Stone.)

The comparative urea was 0.6 per cent on the right and 0.1 per cent on the left. Pyelograms were made by gravity method, the burettes being elevated only 18 inches, and she complained of great discomfort after 2 c.c. had entered the right and 1 c.c. the left. Believing that the left side was incompletely filled more pressure was used, but without effect (Fig. 7). The left kidney appeared to be nodular.

Physical examination (August 8, 1931), by Dr. L. B. Coblentz, was negative except for a blood pressure of 100/70, subnormal temperature, basal metabolism minus 24, red blood cells, 3,740,000, Hb. 81 per cent, slight tenderness over left kidney, pubic escutcheon was of the masculine type and there was evidence of the frequent use of the razor over the face, arms and legs. The clitoris and labia were enlarged. The impression was "ductless gland deficiency (suprarenal, thyroid and pituitary), but tumor of suprarenal must be considered."

August 10, 1931, intravenous injection of skiodan gave characteristic spider-like deformity of left pelvis (Fig. 8).

Two weeks later she was cystoscoped on two occasions by a colleague and the first time his findings were confusing, but the second time a normal left pyelogram was found (Fig. 9).

Comment: The passage of the ureteral catheter apparently caused a temporary partial inhibition of the left kidney resulting in a marked reduction in function and a poor retrograde pyelogram. Two days later the function was still abnormal and there was a misleading intravenous pyelogram; at the end of ten days a defective differential phthalein and an unsatisfactory retrograde pyelogram were obtained, but several days later there was an equal and normal function and normal retrograde pyelograms. (Incidentally, it is unfortunate for the future of the patient that the intravenous urogram was incorrect and that she appears to have a normal left kidney.)

SUMMARY

1. Intravenous pyelography should be used as a routine in the case of suspected ureteral stone. If the medium is eliminated equally well from both kidneys, there is no ureteral stone.

2. Intravenous pyelography is not of direct value in the diagnosis of obstructing non-shadow casting ureteral stones, but is of distinct value in excluding stones from the diagnosis.

3. In cases of "acute" ureteral stone there will be a good pyelogram on the unaffected side and an increased density of the kidney on the affected side, but no outline of the pelvis or ureter, or a very much delayed one.

4. "Chronic" ureteral stones that partially block the ureter routinely show a

well-outlined pelvis, secondary to stasis, and a varying grade of hydronephrosis of the pelvis. If the stone blocked the ureter completely, there would be a functionless kidney above and hence no pelvic shadow.

5. The early reflex inhibition from the ureteral irritation acts to protect the kidney from an early hydronephrosis. The reduction in ability to secrete the medium is apparent rather than real.

6. The increased density of the affected kidney indicates a concentration of the medium between the glomeruli and the distal end of the connecting tubules, the medium being of equal concentration in the blood of both kidneys.

AN ASCENDING FOREIGN BODY IN THE KIDNEY PELVIS*

By T. P. WARING, M.D., *and* ROBERT DRANE, M.D.
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ON NOVEMBER 15, 1927, C. H., a white male, aged thirty-seven, reported on account of pain in the right upper quadrant, nausea, vomiting and fever. His medical history was of no interest except for an attack of hematuria fourteen months ago, and a similar but milder attack of pain and fever one month ago. There has been no pain suggestive of renal colic.

FIG. 1. Showing the foreign body in the region of the right kidney.

Physical examination was essentially negative except for the abdomen. There was fullness in the right flank, some muscular rigidity, tenderness anteriorly and posteriorly. Temperature was 99.4°F., pulse 95, respiration 20, white blood cells 16,800, with 93 per cent polymorphonuclears. The urine was always alkaline. It showed a trace of albumin, a positive benzidine test, many clumps of pus cells, and many red blood cells. Three glass tests showed equal turbidity. Prostatic examination was not abnormal.

A diagnosis of right-sided pyelitis was made, and the usual treatment instituted. The symptoms subsided, but the urinary findings remained the same.

On December 19, cystoscopy was done. The report was: Bladder negative except for redness of the right ureteral orifice. A wax tipped catheter was passed 28 cm. up the right ureter. There was no scratch. Urine collected from each ureter showed:

	Right	Left
Culture	*Staphylococcus aureus*	No growth
Microscopic	Pus in clumps	No pus
Indigo-carmine	Faint	Moderate
Phenolsulphonphthalein (15 min.)	3.5	18.0

Urinary examination for tubercle bacilli was negative.

On January 4, 1928, roentgen examination showed "a shadow, 2.5×0.2 cm. in the region of the pelvis of the right kidney which probably represents a calculus." The pyelographic medium obscured this shadow and showed a dilated irregular ureter with some changes in the pelvis and calyces.

At operation on January 6, 1928, a foreign body 2.5×0.2 cm. was removed from the right renal pelvis. In removing the calculus it broke, and examination disclosed a calcium and phosphate encrustation upon a portion of seed-bearing grass. Several days later another portion of grass and stem was discharged from the wound. Recovery was uneventful except that the urine continued to show some pus cells.

Careful and pointed questioning disclosed the fact that this patient had been in the habit of stimulating his urethra with grass or straw, and that on the occasion previous to the first attack of hematuria, a portion of seed-bearing grass had escaped his grasp and disappeared into his bladder. He watched faithfully each time he voided, but he had never passed this grass.

* This case was reported from the surgeon's standpoint by T. P. Waring.[6] Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22–25, 1931.

How this foreign body ascended the ureter is a question. Much work has been done upon the urinary tract, the best by Graves and Davidoff, Gruber, and Kirwin. They have studied peristalsis, and established the fact that there is antiperistalsis and reflux in the ureters. It is our opinion that during urination and bladder contraction the end of the foreign body happened to be introduced into the ureter and that the sagittate arrangement of the seed upon the stem caused it to work its way during muscular movement and peristalsis up the ureter.

We attempted to prove this theory. Under ether anesthesia a dog's bladder was opened. The ureteral orifices could not be located, so the right ureter was severed at the bladder. No peristalsis was detected in the ureter and very little urine was excreted. A portion of seed-bearing grass, sagittations pointing upward, when placed in this ureter, remained stationary as long as the ureter was not disturbed. However, the amount of manipulating which occurred in searching for the left ureter caused the grass to disappear and ascend 2 cm. up the ureter. More work will be done to confirm movement.

Fig. 2. Pyelogram showing the foreign body surrounded by the opaque medium.

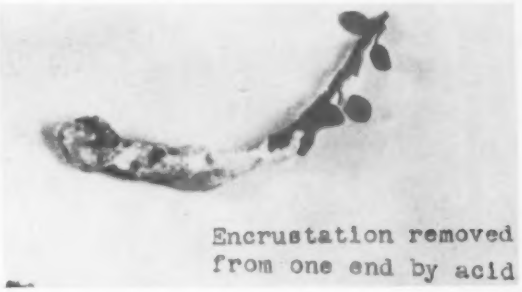

Fig. 3. Foreign body after removal.

Fifty letters were addressed to leading urologists and surgeons throughout the country asking if they had heard of similar cases. Of the forty-eight who answered, only two cited cases in any way similar to this one. Dr. Barney, of Boston, has a calculus which partially surrounds a tooth pick which was removed by one of his colleagues from the kidney pelvis. They concluded that this tooth pick had been swallowed and found its way through the bowel into the kidney. Dr. Braasch, of Rochester, reported a calculus encrusted about a hair pin which was removed from the ureter. This hair pin had been introduced into the bladder. So far as we can determine, our case is unique, and it is our opinion that it was the sagittate character of the foreign body which caused it to migrate.

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DISCUSSION

Dr. Charles A. Waters, Baltimore, Md. It is very difficult to discuss a type of case with which one has had no experience. This is a very rare condition. I believe Dr. Drane stated that he could find references to only two of them. There are several interesting phenomena about such a condition: first, the mechanism of its occurrence, and, second, the inexplicable infrequency of such ureteral ascent.

In the Brady Clinic we have had a good many foreign bodies in the bladder, such as asparagus tips, chewing gum and even goose gravy. Almost all of these cases formed calculi as a result of deposition of uriniferous salts. How such a foreign body ascends a ureter must depend upon one of two things, either reverse peristalsis, which I am told by our urologist has never been actually proved in man, though it has been proved experimentally in animals, or by ureteral reflux. That being the case, it would certainly appear that in Dr. Drane's case the foreign body ascended the ureter by means of ureteral reflux due to a combination of infection in the bladder, changes in the ureteral orifice, the intramural portion of the ureter and the ring muscles in that region with overdistention in a bladder with good musculature.

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STATUS AND CLINICAL APPLICATION OF ROENTGENOLOGY OF THE THORACIC AORTA*

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IN THIS presentation, the noun aorta and the adjective aortic are to be interpreted as applying to the thoracic portion of the vessel.

The technique of roentgen examination of the aorta will not be considered, and the differential roentgen diagnosis of the various common aortic diseases will be discussed only when a correct evaluation of the clinical application of the roentgen method of examination makes necessary such discussion.

At the outset attention is called to the futility of a study of the aorta without a coincident study of the heart. The study of the one to the exclusion of the other is almost impossible, for in all cardiac problems the condition of the aorta must be considered, and likewise in many aortic problems the normality or abnormality of the heart is of importance. The problem is therefore usually a cardiovascular one. Cardiac roentgenology will be discussed only so far as it is related to aortic disease.

Status of Roentgenology of the Aorta

In suburban roentgen practice only occasionally are cases referred for roentgen study of the heart and great vessels. This is true in roentgen practice in metropolitan areas also, except in large hospitals, where teaching of roentgenology is a part of the activity of the roentgen department. Some of the largest clinics in the United States have no organized department of cardiovascular roentgenology.

Patients with symptoms suggesting disease of the circulatory system are not referred for roentgen examination in any such percentage as are patients with symptoms suggesting disease of either the gastrointestinal or respiratory tracts.

It is my opinion that roentgen examination is an essential in the diagnosis of aortic disease and that without its aid a large percentage of the cases of aortic disease will pass unrecognized. This opinion, as will be shown, has the concurrence of eminent in-

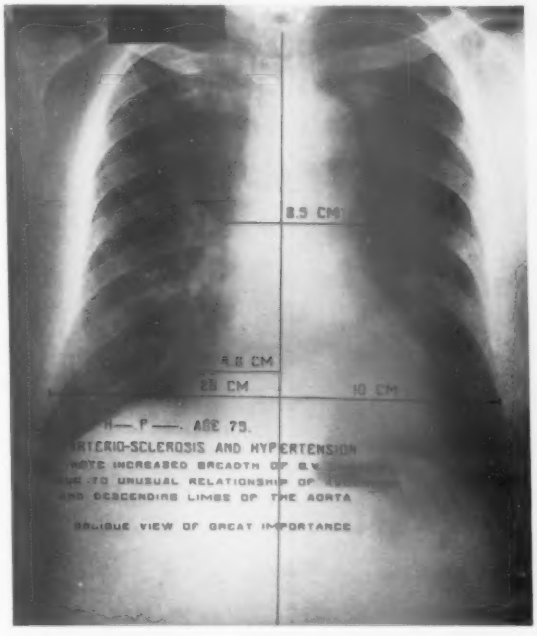

FIG. 1. Increase in supracardiac dullness due to anatomical cause. Supracardiac shadow shows 25 per cent increase above normal. No dilatation of the aorta present. Increase is due to anatomical variation in relationship of ascending and descending parts of the thoracic aorta.

ternists and cardiologists. Roentgen examination of the aorta is not barren in results, as its infrequency might suggest. On the contrary, it is markedly efficient in showing definite aortic pathology not discoverable by other methods of examination, and it is also valuable in a negative sense by excluding aortic disease as the cause of intrathoracic or cardiac symptoms simulating those of disease of the aorta. Further proof of the value of this method of examination is forcibly shown by the installation by many cardiologists of their

* Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22–25, 1931.

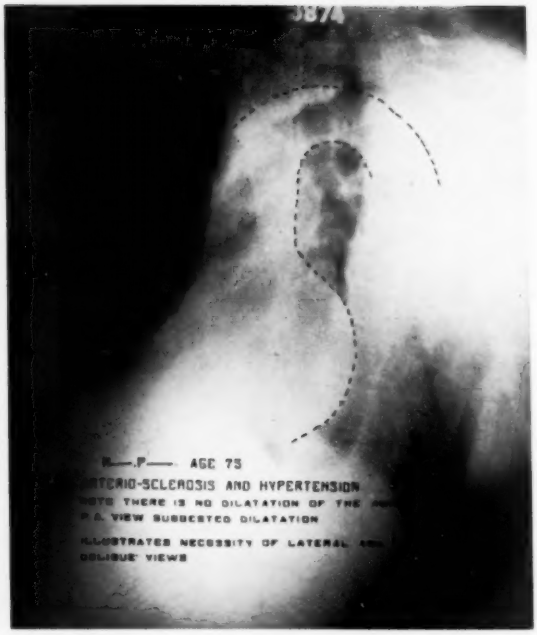

Fig. 2. Oblique view of same case as shown in Figure 1. Note the absence of dilatation of the aorta and also absence of any marked lengthening of the arch.

own roentgen-ray apparatus, which permits them to roentgenoscope practically all of the patients whose symptoms suggest cardiovascular disease.

It will be shown that aortic disease is not of such rare occurrence as to justify an attitude of indifference toward any method of examination which will aid in its detection. It will also be demonstrated that other factors which enter into the diagnosis do not possess such accuracy as to render roentgen examination unnecessary. It is therefore pertinent that inquiry be made to elicit the reasons for this indifference to the roentgen method of examination of the aorta manifested by the majority of internists and practitioners and by many roentgenologists.

There are several reasons which suggest themselves for this infrequency of roentgen examination:

(1) Many roentgenologists are not familiar with the normal roentgen anatomy of the heart and great vessels, and being ignorant of the normal, they are consequently incapable of judging what is abnormal.

(2) Many roentgenologists do not know the complete technique of a properly conducted roentgen examination of the heart and great vessel and are not familiar with what data such an examination can or should reveal.

(3) This failure on the part of roentgenologists as a group to familiarize themselves with the normal and pathological roentgen anatomy of the aorta has resulted in a lack of cooperative effort between clinicians and roentgenologists. Naturally it is unreasonable to expect clinicians to have enthusiasm for, and confidence in, any special method of examination, when those who practice the specialty, of which the examination is a part, display but little zeal and only slight interest in its employment.

(4) Many practitioners (but not many cardiologists) feel competent to diagnose aortic disease without roentgen aid.

(5) Since most practitioners still think of cardiac and aortic disease in terms of mur-

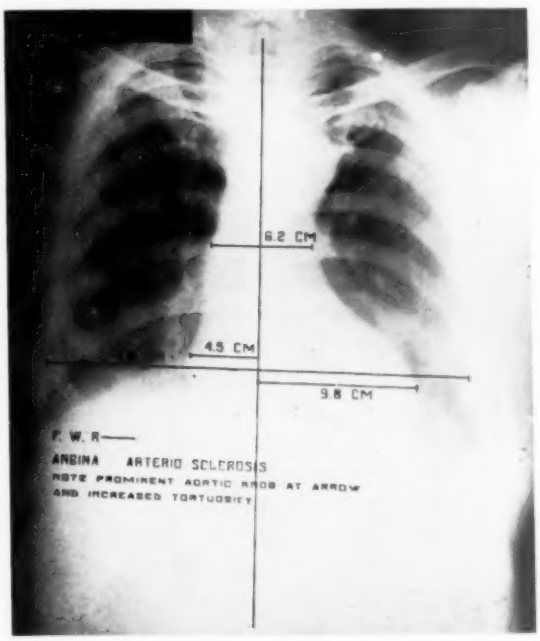

Fig. 3. Angina pectoris. Roentgen diagnosis, arteriosclerosis. This furnishes no therapeutic indication. The value of these findings lies in the exclusion of syphilitic aortitis.

murs, their conception is that, if there is no murmur, there can be no aortic disease.

(6) The information which may be derived from a properly conducted roentgen examination of the heart and great vessel is not well known to the rank and file of the profession, and although the cardiologist and internist see many cases of aortic disease, the greater number of such cases still come, at least primarily, under the care of the general practitioner for diagnosis and treatment.

(7) The laity have not yet become educated to the value of the roentgen examination of the heart and great vessel, and therefore do not suggest it as part of their examination, as is their custom in gastrointestinal and pulmonary diseases.

Conditions Which Suggest the Need of Roentgen Examination of the Great Vessel

(1) Angina pectoris.

(2) Substernal distress, not anginal in character.

(3) Paroxysmal dyspnea, especially nocturnal.

Fig. 4. Oblique view of same case as shown in Figure 3. Typical arteriosclerosis.

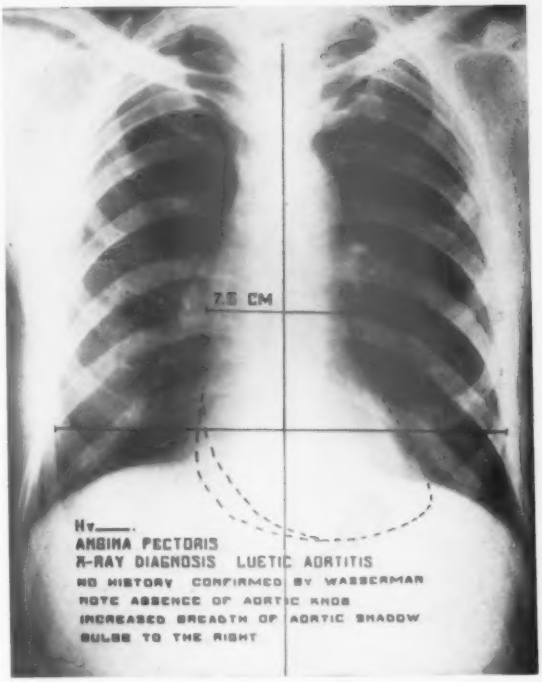

Fig. 5. Angina pectoris. Roentgen diagnosis, syphilitic aortitis. Therapeutic indications furnished by roentgen findings.

(4) Unexplained cough, especially if unproductive.

(5) Unusual pulsations.

(6) History of precedent syphilis, especially in middle-aged persons.

(7) Evidences of disturbed cerebral circulation, not explained by other methods of examination.

(8) At times, hypertension.

(9) Aortic valve disease, especially aortic regurgitation.

(10) Atypical unexplainable cardiac conditions.

(11) Heart block, especially in middle-aged persons.

These are the symptoms and conditions in which a roentgen study of the aorta has proved valuable in my practice.

Summary of Data Which May Be Derived from the Roentgen Examination of the Great Vessel

(1) Accurate diagnosis of the presence or absence of increased supracardiac dullness.

(2) Differentiation of anatomical from

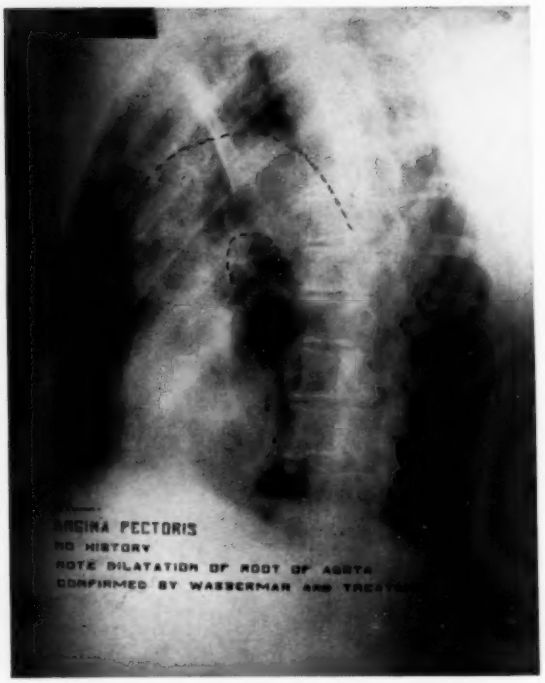

Fig. 6. Oblique view of same case as shown in Figure 5. Typical syphilitic aortitis.

pathological causes of increased dullness when present.

(3) Practical estimation of the anteroposterior diameter of the aorta.

(4) Visualization of pulsations normal or abnormal.

(5) Visualization of aneurysmal dilatation when present.

(6) Differentiation and identification of the causes of increased supracardiac dullness.

(7) At times identification of calcification in the aorta.

(8) Practical estimation of the length and tortuosity of the aorta.

Clinical Application of the Roentgen Examination

All examinations in the practice of medicine, whether conducted in the clinical room or the laboratory, have one or more of three purposes as their ultimate aim:

(1) The cure of the disease.

(2) The alleviation of the symptoms where cure is not possible.

(3) The establishment of scientific data, which in an advancing state of medical knowledge may be applied to either of the two foregoing objectives. A roentgen diagnosis of arteriosclerotic disease of the aorta or a diagnosis of hypertensive aortic change adds nothing to the therapeusis of the individual case thus examined. The chief value of establishing either of these diagnoses lies in the exclusion of luetic aortitis. Roentgen examination is of avail in these diseases, not in the aortic examination, but in the roentgen examination of the heart itself, and in the demonstration of disturbed visceral or peripheral circulation. It does not necessarily follow that this may always be so, for quite possibly the accumulation of scientific data may effect such changes that medical science may yet make use of the roentgen findings of arteriosclerotic and hypertensive aortic change as an indication for therapeusis.

The converse, however, is true of a diagnosis of luetic aortitis. Here the establishment of the correct diagnosis may, and often does, indicate the correct therapeutic

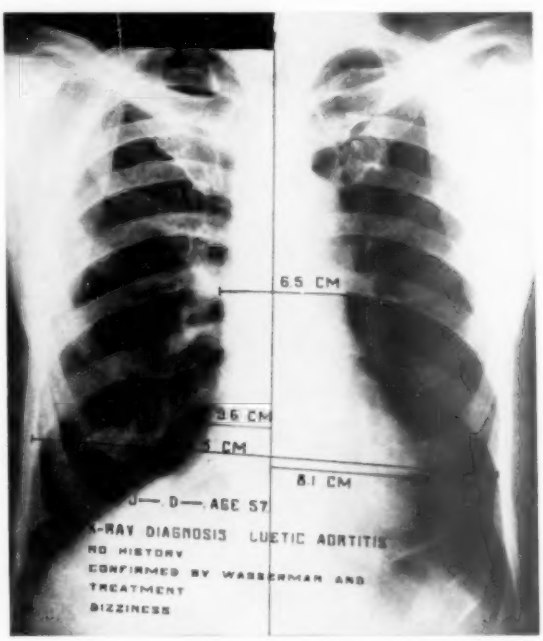

Fig. 7. Vertigo. Roentgen diagnosis, syphilitic aortitis. Therapeutic indications provided by roentgen findings.

pathway, not only for the treatment of the aortic disease per se, but also for the treatment of the constitutional condition, of which indeed it may be the only available diagnostic evidence. It is because of this definite therapeutic indication that in the present state of medical knowledge luetic aortitis looms up as the most important of the various aortic diseases.

To realize how common luetic aortitis is, necessitates an examination of the statistics of syphilis in general and syphilitic aortitis in particular.

Statistics as to the Frequency of Syphilis
(Population of United States 122,000,000.)

Stevens[13] states, "About 20 per cent of all hospital patients and at least 10 per cent of the entire population give evidence of infection." Ten per cent is 12,000,000.

Mackenzie[8] says, "It may be assumed from clinical experience that 10 per cent to 15 per cent of these patients (hospital) suffer or have suffered from syphilis."

It is laid down by Parran[9] that a study of statistics "warrants the statement that there are in this country 643,000 cases of

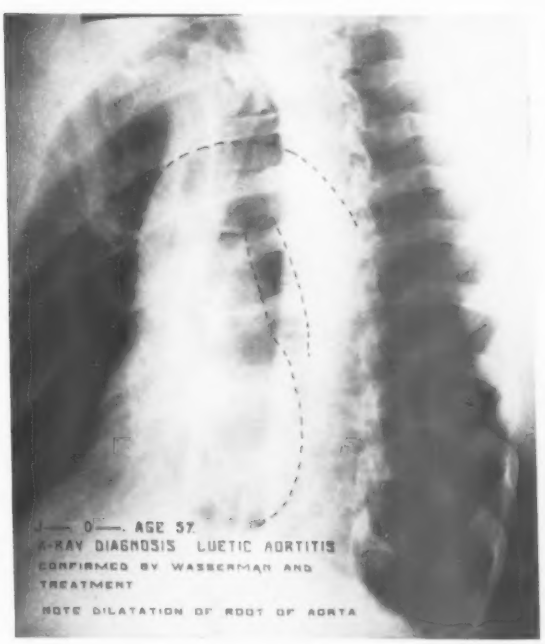

Fig. 8. Syphilitic aortitis. Oblique view of same case as shown in Figure 7.

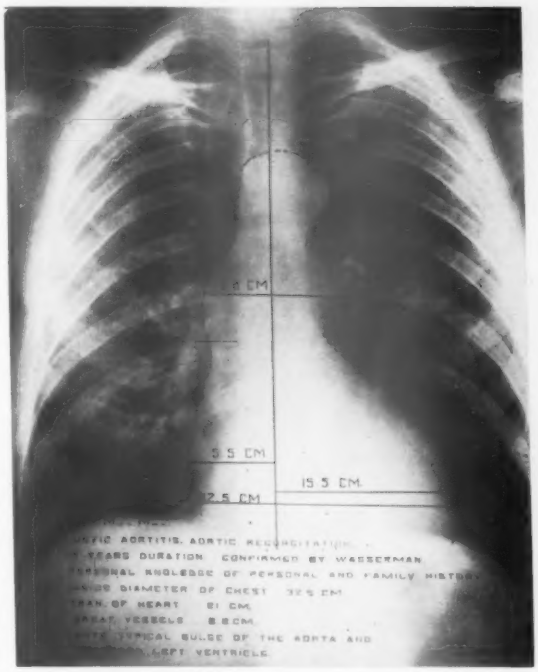

Fig. 9. Attacks of paroxysmal dyspnea, thirteen years ago. Roentgen diagnosis made at that time, syphilitic aortitis. Aortic regurgitation and secondary changes in heart now present.

syphilis constantly under medical care of which 35 per cent or 225,000 are early cases and that no less than half a million (500,000) new infections occur for which treatment is sought each year."

Stokes[15] places great reliance on "the conservative estimate of the British Royal Commission, 7 per cent to 10 per cent of the population as representing the proportion infected with syphilis. It is very nearly the commonest and easily one of the most fatal of the serious diseases which affect mankind."

Statistics as to the Frequency of Syphilitic Aortitis

Stevens[14] states that aortitis "occurs in 15 per cent to 20 per cent of all cases showing clinical evidence of syphilis, also that syphilitic aortitis is found in 4 per cent to 7 per cent of all hospital necropsies and in at least three-fourths of all bodies showing other well marked evidences of acquired syphilis."

M..M..
LUETIC AORTITIS. AORTIC REGURGITATION.
MARKED DILATATION OF ASCENDING AORTA.
TYPICAL EXPANSILE BULGE OF AORTIC WALL

Fig. 10. Syphilitic aortitis. Oblique view of same case as shown in Figure 9.

McCrae,[6] discussing acute aortitis, writes, "This is much more common than is usually recognized. Of greatest importance is its occurrence in syphilis"; and also discussing chronic aortitis he states that "this is a common condition frequently overlooked."

Mackenzie states, "Discussing 288 necropsies in which the organic lesions of syphilis were found, 60 per cent showed evidence of aortitis." He also states, "Turnbull's figures would show that 25 to 30 per cent of those having syphilitic infection developed aortitis."

Lamb[1] says, "Syphilitic aortitis is not an uncommon disease. It is found in 4 to 7 per cent of autopsies in general hospitals. It comprises 15 to 25 per cent of organic heart disease and is present in from 50 to 75 per cent of syphilitics."

Summary of Statistics of the Incidence of Syphilis and Syphilitic Aortitis in the United States

Population of United States = 122,000,000
Percentage affected with syphilis 10 per cent = 12,000,000
Percentage of syphilitics developing aortitis 20 to 30 per cent = 2,000,000 to 3,000,000
Percentage of aortitis in autopsied cases showing other organic lesions of syphilis = 70 per cent
Percentage of organic heart disease result of syphilitic aortitis = 15 to 25 per cent
Yearly crop of new syphilis in the United States = 500,000
Ten-year crop of new syphilis in the United States = 5,000,000
Ten-year crop of syphilitic aortitis in the United States = 1,000,000 to 1,500,000

Evidence and Opinions of Other Than Roentgenologists as to the Value of the Roentgen Examination in Aortitis and Aneurysm

Lamb,[2] discussing luetic aortitis, says of laboratory examinations, "Two of these are of the *greatest importance*,—the Wassermann test and the *x-ray examination*. It is in these cases of uncertainty that the x-ray examination is of the utmost importance, frequently the deciding factor."

Discussing the diagnosis of aneurysm,

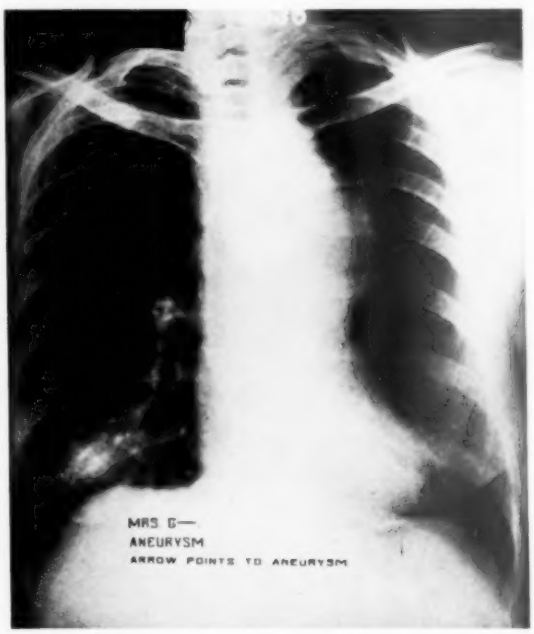

Fig. 11. Unproductive cough, three years' duration. Clinical diagnosis, chronic bronchitis. Roentgen diagnosis, aneurysm of descending aorta. Some eminent clinicians believe antisyphilitic therapy is of decided palliative value in some aneurysms.

the same author observes,[3] "After all is said about physical examination in these cases, and important and interesting as it may and should be to make the diagnosis of aneurysm by this method, it is the x-ray to which we turn for the substantiation of our surmises and frequently to our humiliation in the unsuspected case."

Scott[12] states, "Valuable objective evidence to substantiate the diagnosis of syphilitic aortitis is afforded by the x-ray."

McCrae,[7] discussing aneurysm, says, "An x-ray study should be made in all doubtful cases. The diagnosis may rest upon it in cases in which scarcely a physical sign is present."

Levine[5] states, "I agree with you emphatically on the importance of x-ray examination in the diagnosis of luetic aortitis. Aneurysm can frequently be diagnosed only by x-ray examination, and in early luetic aortitis without aneurysmal formation, the x-ray is an extremely valuable aid."

Robey[11] observes, "I think you can unquestionably quote me as saying, that the roentgen examination is frequently a valuable aid and often diagnostic in the detection of luetic aortitis."

Fig. 12. Oblique view of same case as shown in Figure 11. The fusiform aneurysm of the descending aorta is well shown in this view.

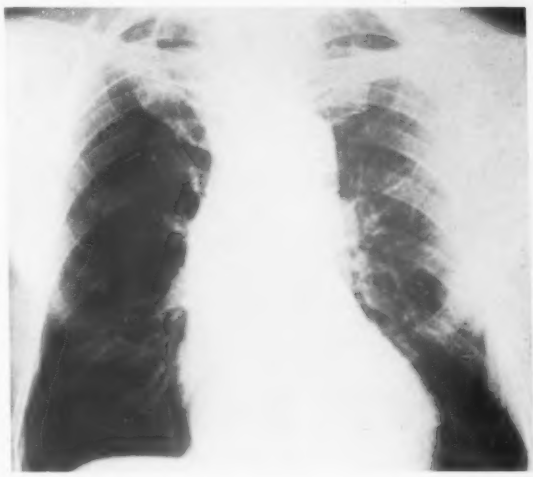

Fig. 13. Roentgen diagnosis, syphilitic aortitis with extensive atheroma. Note the increase in the diameter of the ascending aorta, and also the extensive atheromatous involvement in the right border of the ascending aorta.

White[17] says, "The Roentgen examination is at all times a valuable aid, and many times diagnostic in the detection of luetic aortitis. However, luetic aortitis may be present with no evidence of its presence by roentgen examination, and well marked general dilatation of the aorta may occur in other conditions besides luetic aortitis, especially in chronic hypertension and marked chronic aortic regurgitation."

Status of Other Diagnostic Factors Than Roentgen Examination in Syphilitic Aortitis

Clinical Examination. In a recent study of 78 autopsied cases of syphilitic aortitis, Reid[10] found error in clinical diagnosis to exist in 44 per cent of the cases, and of them 34 per cent were advanced cases. These cases occurred, not in suburban or rural districts, but in two of the large metropolitan hospitals of Boston, where expert knowledge, skill and facilities exist. If such a percentage of error in the clinical diagnosis of syphilitic aortitis appears in large metropolitan hospitals, where scientific diagnosis has reached a high point

Fig. 14. Oblique view of same case as shown in Figure 13. The dilatation of the ascending aorta is well shown, also the atheromatous changes in the borders of the ascending aorta.

of accuracy, and where syphilitic aortitis is always under consideration in cardiac problems, what must be the percentage of error in suburban and rural districts, where syphilitic aortitis is usually but a faint memory of a troublesome entity which was memorized in student days? There must be but few, if any, other common diseases which in the hands of conscientious skillful clinicians will show 44 per cent of clinical diagnostic error.

Serology. Lamb[2] observes, "This reaction (Wassermann) is positive in about 80 per cent of proven cases. A negative Wassermann means, therefore, that there is still some 20 per cent chance that the disease may be syphilitic aortitis."

Stokes[16] states, "Elliott places the margin of error of the negative blood Wassermann reaction in syphilitic vascular disease as high as 40 per cent. In 54 necropsies in cases of syphilitic disease of the aorta, Reid reports that 17 per cent were Wassermann negative on the blood shortly before death. Cummer and Dexter, 75 per cent positives in 36 cases. Error 25 per cent. Longcope 74.5 per cent positive in 47 cases. Error 25 per cent. Longcope summarizes the results as follows: In general syphilitic vascular disease as positives 25 to 68 per cent. In aortic insufficiency 75 to 80 per cent. In aneurysm 90 to 95 per cent. In aortic disease 75 to 88 per cent."

Scott[12] observes that "the percentage of positive reactions reported by various authors varies considerably. In the writer's series it was 85 per cent. Error 15 per cent."

Levine[4] in 40 proved cases of luetic aortitis found the blood Wassermann test negative in 30 per cent.

Fig. 15. Another view of the same case as shown in Figures 13 and 14. The atheromatous changes in the ascending aorta, extending into the arch, are well shown. This case illustrates the necessity for roentgen examination and the therapeutic indications furnished thereby. The dilatation of the aorta would probably escape detection without roentgen examination. The roentgen diagnosis of syphilitic aortitis gives a definite therapeutic indication. Therapeusis is of little, if any, avail in atheroma, but if the syphilitic aortitis is recognized by roentgen examination, antisyphilitic treatment would probably be of value.

Twenty to 30 per cent error in serology is probably a conservative estimate in syphilitic aortitis. This means that in 20 to 30 of each 100 cases of syphilitic aortitis the diagnosis will not be suggested or aided by the blood serum examination. If the estimate of the number of syphilitic aortitis cases in the United States as stated by various authorities is approximately correct, it follows that in 600,000 to 800,000 of the cases of this disease now in the United States, the blood examination will be of no value in suggesting or proving the existence of the disease, and the correct diagnosis must be made without its aid.

Conclusions

Several facts stand out pre-eminently in this study:

(1) The unanimity of widely diversified authorities regarding the incidence of syphilis and syphilitic aortitis.

(2) The concurrence of eminent cardiologists regarding the valuable aid which the roentgen examination affords in the diagnosis of the most important of aortic diseases—syphilitic aortitis.

(3) In vivid contrast, the attitude of indifference manifested by the medical profession in general, and roentgenologists in particular, to the use of the roentgen examination.

Certain postulates may now be stated, the truth of which is almost axiomatic:

(1) Syphilitic aortitis and other aortic diseases form a group of common diseases, the diagnosis of which is frequently missed.

(2) Roentgen examination of the great vessel has been demonstrated; it is conceded by competent authorities to be frequently a valuable aid; and many times an essential to the diagnosis of aortic disease.

(3) The omission commonly to employ a method of examination, which is almost universally approved, as a valuable aid in the diagnosis of what is conceded to be a group of common pathological conditions, is unjustifiable negligence, and educational efforts should be promoted to correct it.

I wish to offer the following suggestions regarding the educational measures which should be promoted:

(1) The dissemination of the incidence of aortic disease and especially of syphilitic aortitis among the large body which constitutes the medical profession.

(2) The education of those who for want of a better term may be called ordinary roentgenologists in the technique of roentgen examination, and the interpretation of roentgen findings in aortic disease.

(3) The demonstration to the medical profession at large by oral and literary contacts of the aid which roentgen examination can give in the diagnosis of aortic disease.

(4) Intensive and extensive cooperative efforts among leading roentgenologists, clinicians, and pathologists in the correlation of their findings in their respective specialties, as applied to aortic disease, with a view to the establishment of standard diagnostic criteria, and especially such criteria as apply to early diagnosis.

It can only be by the correlation of roentgenological, clinical, and pathological findings that a scientific basis may be laid for the advancement of roentgenology of the aorta.

Roentgenology is not infallible in aortic disease. It must, however, merit the approbation which eminent cardiologists have given it, for otherwise they would not have bestowed it. It does not, I am sure, deserve the attitude of complacent neglect with which some roentgenologists and the large bulk of the medical profession have treated it.

The problem is undoubtedly a vast one. Any disease which involves two to three million people in the United States is certainly appalling in it immensity. Its vastness, however, should be no excuse for the pusillanimous attitude adopted toward it, but should rather serve as an incentive to greater effort to solve it. Surmounting a molehill of difficulties gives no joy of accomplishment; surmounting a mountain gives satisfaction and reflects credit.

It is a sad but true comment that, even with the present advanced state of medical knowledge, many cases of aortic disease are not recognized until the patient is seriously or permanently disabled or perhaps is on the autopsy table.

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DISCUSSION

Dr. David Steel, Cleveland, Ohio. I certainly agree with Dr. Sproull, and I am sure everyone who has used the roentgen method in the diagnosis of cardiac lesions would agree, that the method has a great deal of value and has too long been neglected. It has been my experience that those clinicians who have studied abroad, particularly in Vienna, where apparently every cardiac case is studied roentgenologically, and those clinicians who have been educated in our own clinics where the method is used, have found that it is such a valuable adjunct as not only to warrant its routine use, but also to accept its conclusions in many cases where the roentgenological and clinical diagnoses differ. We should certainly recognize our shortcomings, which in cardiac roentgenology are multiple and were well pointed out by Dr. Paul White before this Society in New York in 1930. What we can elicit by the method is perhaps more valuable to us in this discussion. The advantages can be briefly summarized as: (1) Changes in the cardiac cone can be accurately recorded and used as a basis of comparison in the future. (2) The method is far more accurate than percussion for determining size, especially in certain normal and pathological conditions. (3) It is the only method available for the study of the size and shape of the left auricle, pulmonary artery and its main branches. (4) It is the only method for the actual study of cardiac pulsations and mobility. (5) It is the most accurate method for the actual demonstration of position, relations, density, size and pulsation of the aorta. (6) It is the only sure method for positive diagnosis of aneurysmal dilatation. It not only shows the origin of the sac, but demonstrates its relation to other important structures. (7) Often obscure lesions can be detected alone by the method, for example, the occasional case of mitral stenosis which gives no murmurs save during the brief effect of amyl nitrite inhalations, or the second lesion of a combined endocarditis where the first obscures clinically the second, or the occasional aneurysm of the left ventricle, or extreme dilatation amounting to aneurysm of the left auricle, etc. In this group is also included the roentgen diagnosis of syphilitic aortitis. It seems too dogmatic to say that the roentgenologist alone is able to definitely diagnose this lesion. It is a fact that luetic aortitis should be suspected when (1) a diffuse dilatation is present and is associated with a normal-sized heart silhouette, or (2) when a dense, high aorta is present in a young individual without a previous hypertension, and that the lesion can be safely diagnosed when localized dilatation associated with localized increase in pulsation is demonstrable.

Since 1910 the annual death rate for heart disease has increased from 10.8 to 19.7 per cent, that is, almost doubled. In the same period, the rate for pulmonary and disseminated tuber-

culosis has decreased from 9.1 to 5.6 per cent. In other words, in 1928 heart disease caused about three times as many deaths as pulmonary tuberculosis. We as roentgenologists can be proud of our part in the early diagnosis of pulmonary tuberculosis. With such appalling figures for heart disease, is the time not long past due for us to aid in the diagnosis of cardiac lesions?

Dr. Stafford L. Warren, Rochester, N. Y. As Dr. Steel has just pointed out, cardiovascular disease is one of the very important diseases that concern the clinicians. As a matter of fact, in this country a whole journal is devoted to study of the diseases of the heart. Our specialty affords one of the best methods for the study of heart disease in the living. Before 1900, aneurysms were described from chest plates. The interest of roentgenologists since then has been mainly devoted to the diseases of the lung, and the study of the heart has fallen into the discard. The reason for that is perhaps due to the difficulties of diagnosis by other methods, and a quick checking up of the diagnosis impossible. The clinicians themselves have not been quite clear as to the exact nature of many heart lesions, and autopsy study of the heart by the clinician and roentgenologist has been rare.

On the other hand, the roentgen ray gives us the only method other than study at the autopsy table to actually see the abnormal heart and aorta. It is almost as if we had it in our hands, and we ought to be able to tell with this method (from the fluoroscope and from the films) what lesions are present, not only in the valves but in the muscle and in the great vessels.

As you probably know, I am very much interested in the study of the aorta and the heart from the oblique view. I am very glad to hear Dr. Sproull's discussion of aortic disease and his emphasis on luetic aortitis. I am very much pleased to hear him point out that other lesions may be simulated by luetic aortic disease, and he has clarified some confusion in my own mind about certain arteriosclerotic lesions which I thought were present. I am certain now that they were on the basis of luetic disease and not arteriosclerosis alone.

Dr. Sproull's report of a large series of well-studied cases bears out the opinion that a well-rounded heart examination is just as important as a complete lung examination, and in order to do it thoroughly, it is necessary for us to do a careful fluoroscopic examination and amplify and supplement this by films taken in many views, not alone a standard posteroanterior view, but also oblique views. We must correlate our findings with those of the anatomist, the pathologist and the clinician. This is not difficult to do. It means we must be more broad in our viewpoints and it is perfectly within our powers to do so.

Dr. George W. Holmes, Boston. As most of you know, I have been interested in this subject for a number of years, and I am sure you will all agree with me when I say that such a paper as Dr. Sproull has presented should stimulate renewed effort and a better study of this condition. It seemed to me, too, that the place to present such a paper was before this Society. One might think that our trouble came largely from lack of interest on the part of the clinicians, but my own observations are that it is more often our fault than theirs. It is surprising how few roentgen clinics in this country are equipped to make satisfactory roentgen examinations of the heart and how few roentgenologists are really as interested in this work as they should be. It seems to me that such a paper as this is timely and worth while.

I believe that we are on the verge of a definite advance in cardiac diagnosis. We now have apparatus available which allows us to take plates of the chest and of the heart with sufficient speed at long distances to avoid all movement, and we are certain to make better and more accurate studies of calcification in the heart and in the aortic valves and also to obtain better outlines of the aorta in the various positions than we have ever done before and I believe that a chance to do advance work in this field is before us at the present time. There is no question about the frequency of the disease, or the necessity of roentgen examination. I saw a case only last week that had been coming to the Massachusetts General Hospital out-patient department for several years. She came in with a diagnosis of tuberculosis from a sanitarium, she had râles in the upper part of her chest and signs which might well have been due to tuberculosis. Last week she was x-rayed, and an aneurysm of the aorta which was pressing on a bronchus was found, causing the symptom, which the older writers call aneurysmal phthisis. She had no evidence of tuberculosis. This mistake happens often enough, even in the best clinics, to make the examination necessary in all suspected cases.

Dr. Sproull (closing). I haven't very much to add, except to suggest that we have proof of the necessity for roentgen examination in that many cardiologists are installing facilities for roentgenoscopic examination of the heart and aorta. If the roentgenologists do not take up this subject, cardiovascular roentgenology will pass out of their hands. A roentgenoscopic examination of the aorta is not a complete roentgen examination by any means. Recently I have carried out a study on 100 hypertensive aortas, giving an opinion from the roentgenoscopic examination as to the question of dilatation of the aorta, and not knowing whose films I was looking at, the next morning rendering an opinion on the same point from the films. I have been astounded how many times I have diagnosed a dilated aorta on the roentgenoscopic evidence, and then after examination of the films have changed my opinion.

A roentgenoscopic examination is of value to detect pulsations and variations in the direction of the aorta, but for the detection of dilatation and variations in relationship of the aorta to surrounding structures, films in various positions are necessary.

Vol. XXVIII, No. 1

FRACTURES AND EPIPHYSEAL SEPARATION FRACTURES OF THE ANKLE

A CLASSIFICATION OF THREE HUNDRED AND THIRTY-TWO CASES ACCORDING TO THE MECHANISM OF THEIR PRODUCTION*

By PAUL A. BISHOP, M.D.
PHILADELPHIA, PENNSYLVANIA

FRACTURES OF THE ANKLE

THIS discussion of the classification and mechanism of fractures of the ankle is based entirely on the work of Ashhurst and Bromer.[1] It is intended that it shall serve a threefold purpose: (1) to call attention again to their splendid monograph; (2) to present a second group of 300 classified cases, and (3) to review their classification as a preliminary to its application in the discussion of epiphyseal separation fractures. In so doing, I am making liberal use of their work, especially the paragraphs on the anatomy and motions of the ankle joint, and the mechanism of the production of fractures. The original article is recommended to those who are interested in an exhaustive study of the comparative work of others in this field.

Ashhurst states, "It should be unnecessary to argue the desirability of classification, for without classification the relation of one lesion to another can be neither remembered nor understood in any department of knowledge, and comprehension is a prerequisite for intelligent memory and for rational diagnosis and treatment." Numerous classifications of fractures of the ankle have been suggested, many of them adequate for their purpose, all of them open to criticism; in fact, the most scientific and complete, that of Quènu, "is less a classification than a catalogue," strictly adhering to an anatomico-pathologic classification which places unrelated lesions side by side for no reason except that the fracture lines happen to be similar.

The classification under consideration has been selected because it is simple, practical and workable, grouping together lesions that are related by the manner in which they were produced. Likewise it differentiates between several fractures that may occur in the same structure, i.e., the internal malleolus, that are totally unrelated as to cause or in the method of reduction. Each lesion is given its logical place in a progressive series of injuries produced by a definite force acting in a definite manner. Ashhurst says in his summary: "I believe a classification based on mechanism, imperfect though it be, is nevertheless, more easily understood and remembered."

Anatomy. The ankle joint is formed by the articulation of three bones: the tibia, whose broad, flat, weight-bearing surface forms the roof of the joint and whose internal malleolus forms the medial wall; the fibula, or that portion of it extending below the articular surface of the tibia, known as the external malleolus, and the astragalus below. The articular portion or trochlea of the astragalus is somewhat wider in front than behind, conforming with the divergent directions of the internal surfaces of the malleoli. The posterior aspect of the tibia projects so low that it has been called the posterior malleolus (Destot). This is a frequent site of fracture, the "posterior marginal fragment."

The fibula lies in a groove on the lateral side of the tibia, between the anterior and posterior tubercles. It is held in position by the anterior and posterior tibio-fibular ligaments. A slight amount of motion is permitted but there is no joint space. The foot is attached to the leg by ligaments. The internal lateral ligament passes from the internal malleolus, in three bands, to the scaphoid, to the calcaneus (sustentaculum

* From the Radiological Department of the Pennsylvania Hospital, Philadelphia. Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22–25, 1931.

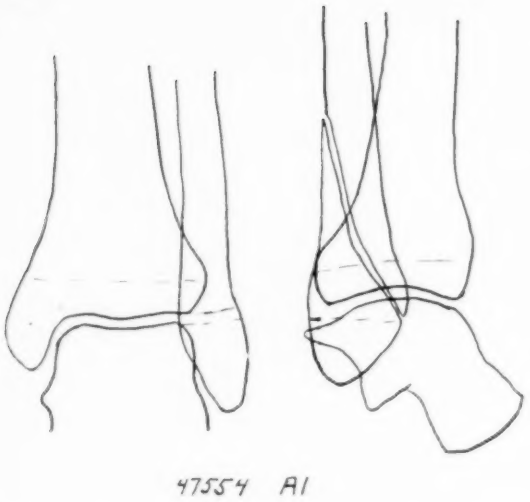

Fig. 1. External rotation fracture, first degree. Characteristic oblique fracture of the fibula above the joint.

tali), and to the median tubercle of the astragalus. The external lateral ligament, which is much the stronger, is divided likewise into three bands, one passing forward to the lateral border of the neck of the astragalus, the middle band passing down and slightly backward to the calcaneus, while the posterior band is attached to the lateral tubercle on the posterior surface of the astragalus at the point casting the furthest posterior shadow on a lateral roentgenogram of the ankle. This posterior band is so exceedingly strong that it is very seldom ruptured and either one bone or the other is fractured, usually the fibula. Figure 8 shows the only case in this series of an isolated fracture of the tail of the astragalus; another was associated with an oblique fracture of the external malleolus.

These ligaments play an important rôle in the production of fractures of the ankle. It should be noted that a malleolus that is fractured almost invariably remains attached to the astragalus by these ligaments and that the displacement of the foot (astragalus) and the malleolus is in unison.

Normal Movements. The normal movements of the ankle, as in all hinge joints, are in a single plane. They are 20° dorsiflexion and 60° extension, around an axis lying at a 30° angle to the bimalleolar axis. Except in this direction movements of the ankle are resisted by the malleoli and their ligaments.

A slight amount of abduction and adduction normally occurs between the astragalus and the calcaneus, which permits the foot to accommodate itself to irregular surfaces in walking. If such lateral motions are too extensive, the strong astragalocalcanean ligament binds these two tarsals together and transfers the force through the astragalus directly to the ankle joint proper. Here, such lateral motion is resisted by the tension of the lateral ligament, and if forced, the malleolus away from which the force is acting is torn off, or the ligament is ruptured. Not until this has occurred can the astragalus exert pressure on the other malleolus to produce a crush fracture.

Internal rotation of the foot is almost inseparable from adduction due to the movability of the tarsals in this direction, but in outward rotation these tarsal joints become fixed and the force is transmitted directly to the ankle joint. Owing to physical laws, the greatest strain falls on the external malleolus. Maisonneuve illus-

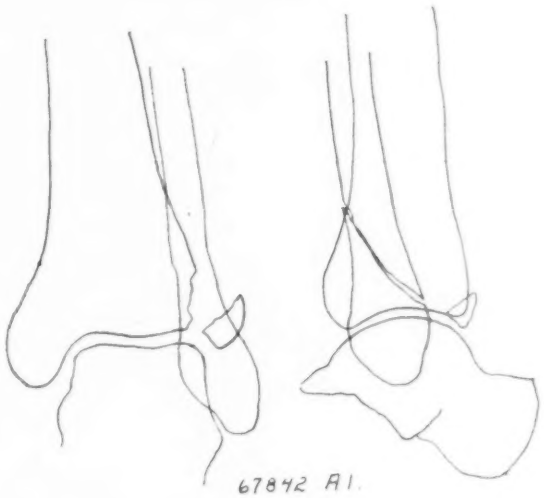

Fig. 2. External rotation fracture, first degree. Detachment of the anterior tibio-fibular ligament by fracture of the anterior tibial tubercle, with fibular fracture above the joint.

trated this by placing a ruler, representing the foot, between two parallel books, representing the malleoli. The volume which is moved is the one on the side toward which the ruler is moved, i.e., external malleolus.

The Mechanism of Fractures. Outward rotation of the foot: This motion is the most frequent cause of fractures at the ankle. If the force continues to act as described in the latter portion of the preceding paragraph, it causes an oblique fracture of the external malleolus (Fig. 1). The line of fracture is characteristic in that it is oblique from above and behind, downward and forward. The obliquity varies greatly but the line of fracture is always higher on the posterior surface of the fibula and usually passes through the tibio-fibular joint, almost invariably to the external malleolus, that is, below the level of the tibial articulation, so that the anterior tibio-fibular ligament is not ruptured and tibio-fibular separation or diastasis does not occur in this simplest type of fracture.

If this oblique fracture is the only lesion, there is little or no displacement; in fact, it is frequently impossible to see the line of fracture in true anteroposterior roentgenograms. Cadaver experiments by Ashhurst have shown that the only movement of the foot that will cause separation of the fragments is external rotation, the lower fragment rotating outward on the posterior tibio-fibular ligament as on a hinge. This is a fact that is apparently not generally recognized, judging from the persistence with which these cases, without displacement in the first place, are sent back, unnecessarily, I think, for roentgenograms to "check up" the position which, just as persistently, is the same.

Fig. 3. External rotation fracture, first degree. Oblique fracture of the anatomical neck of the fibula following rupture of the anterior tibio-fibular ligament.

Fig. 4. Isolated fracture of the anterior tibial tubercle.

In a few cases we find the lower end of the line of fracture above the tibio-fibular joint, in which case the initial lesion is rupture of the anterior tibio-fibular ligament or a fracture at its attachment, the anterior tibial tubercle (Fig. 2). This releases the lower tibial attachment of the external malleolus, on which alone the force is acting, and the fracture of the fibula by torsion will follow, not through the joint but above it, usually the surgical neck (Fig. 2), but even as high as the anatomical neck (Fig. 3). Such a fracture of the upper end of the fibula can occur after rupture of the anterior tibio-fibular ligament without visible bony lesion at the ankle (Fig. 3). Occa-

sionally, following the tearing off of the anterior tibial tubercle, the force is not sufficient to fracture the fibula and this remains the only lesion (Fig. 4).

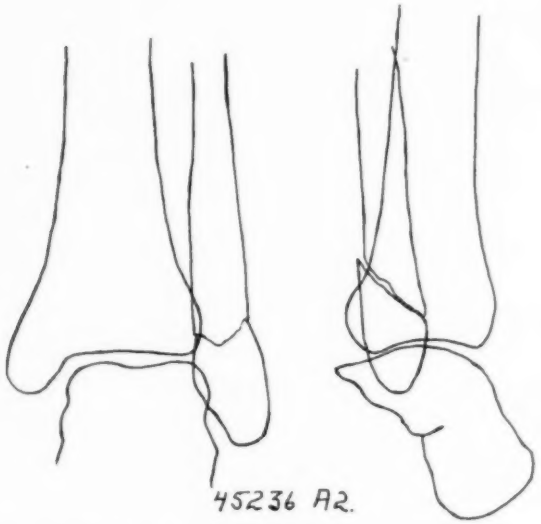

Fig. 5. External rotation fracture, second degree. Rupture of internal lateral ligament represents fracture of the internal malleolus.

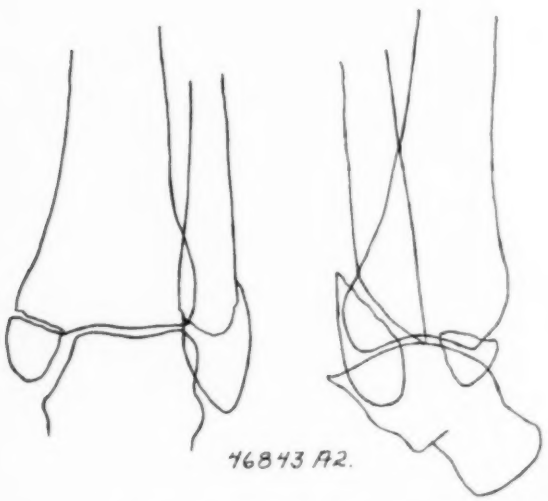

Fig. 6. External rotation fracture, second degree.

The second degree of this type of fracture is caused by a continuation of the force after the fibula has been fractured, the strain falling on the internal lateral ligament which is ruptured (Fig. 5), or the internal malleolus is fractured, the tip only being involved as a rule—low Dupuytren fracture (Fig. 6). The displacement is slight or marked. In many cases there is, in addition, a posterior marginal fragment.

The third degree occurs rarely—only when the avulsive force is sufficient to cause a fracture of the entire lower end of the tibia instead of the internal malleolus (Fig. 7).

Fig. 7. External rotation fracture, third degree. The internal malleolar fracture is represented by fracture of the whole lower end of the tibia.

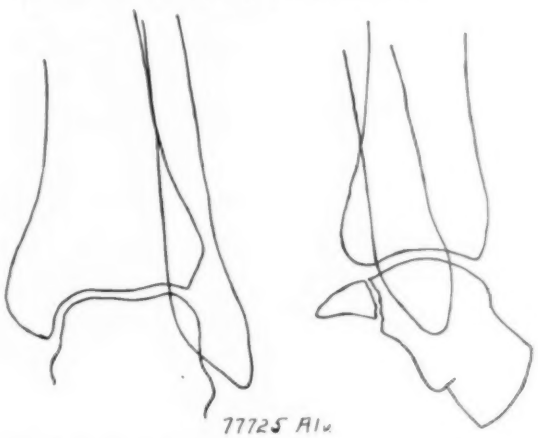

Fig. 8. Isolated fracture of the tail of the astragalus due to tension of the posterior band of the external lateral ligament.

Abduction of the Foot. In forced abduction of the foot the first strain falls on the internal lateral ligament, as has been men-

tioned in the paragraph on movements. If the force is sufficient the first lesion is a rupture of the ligament, or a more or less transverse fracture of the internal malleolus (Fig. 9). Following detachment of the internal ligament, or the malleolar fracture, the astragalus will be forced against the external malleolus, causing the second degree fracture of this mechanism. This may be either of two types:

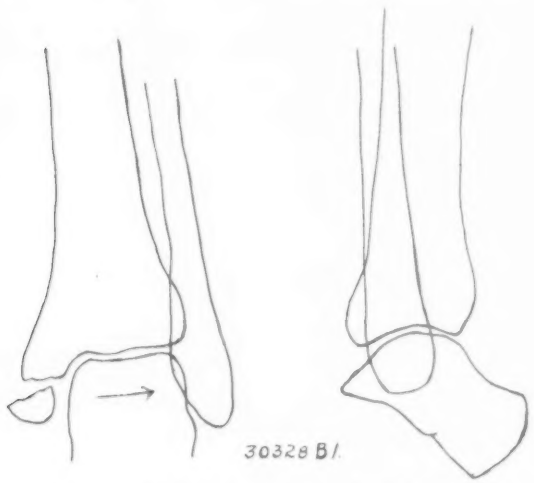

Fig. 9. Abduction fracture, first degree.

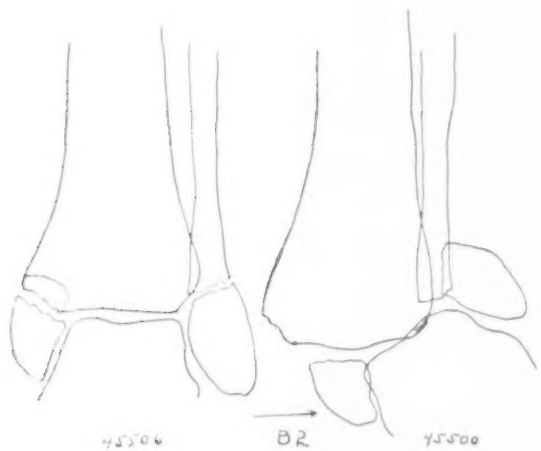

Fig. 10. Abduction fracture, second degree, bimalleolar type. The tibio-fibular ligament is not ruptured.

(1) If the tibio-fibular ligament is not ruptured the fibular fracture is of the crush type, involving the external malleolus only—a bimalleolar fracture (Fig. 11).

(2) If the ligament is torn, the fibula is freed from the tibia, and if the force continues the fibula breaks "by flexion," usually through the surgical neck which is the weakest point—a Pott's fracture, Dupuytren type (Fig. 12).

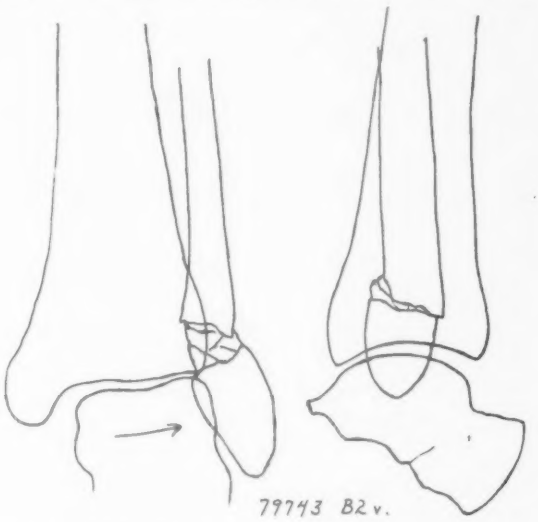

Fig. 11. Abduction fracture, second degree. Fracture of the internal malleolus represented by rupture of the internal lateral ligament.

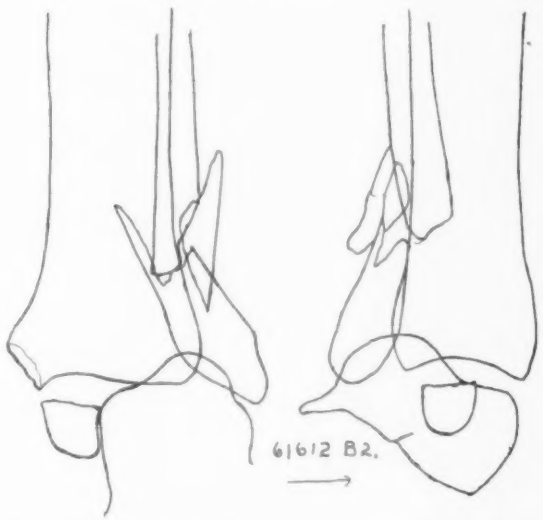

Fig. 12. Abduction fracture, second degree, Pott's type. Rupture of the tibio-fibular ligament permits fracture of the fibula above the joint, by flexion. Note that the malleolar fragments retain their relationship to the astragalus.

The third degree is uncommon, the entire lower end of the tibia being torn off

instead of the internal malleolus as the primary lesion (Fig. 14). The fibular fracture is by flexion through the surgical neck and will not be confused with the oblique

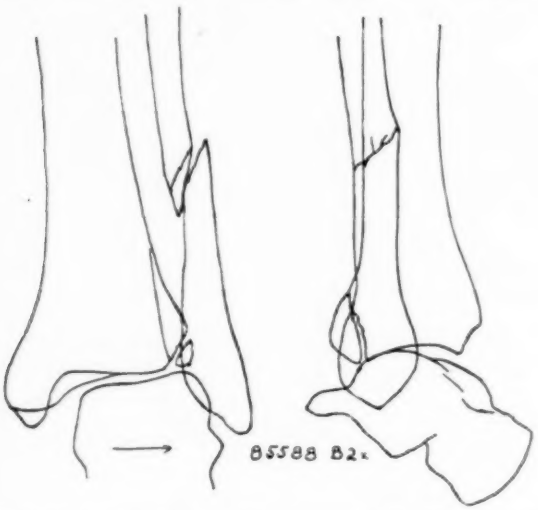

Fig. 13. Abduction fracture, second degree. Fracture of the internal malleolus represented by rupture of the internal lateral ligament.

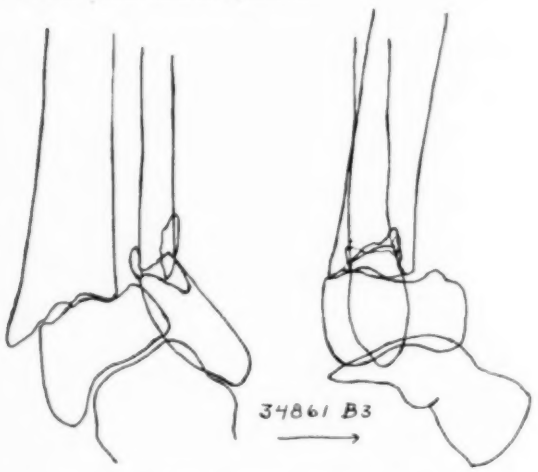

Fig. 14. Abduction fracture, third degree. Fracture of the internal malleolus is represented by fracture of the whole lower end of the tibia.

fracture of the fibula in the third degree of the internal rotation group.

Adduction of the Foot. The mechanism of this type is obviously the reverse of that for the abduction group. The initial lesion is caused by the pull of the external lateral ligament which ruptures, or causes a transverse fracture of the external malleolus

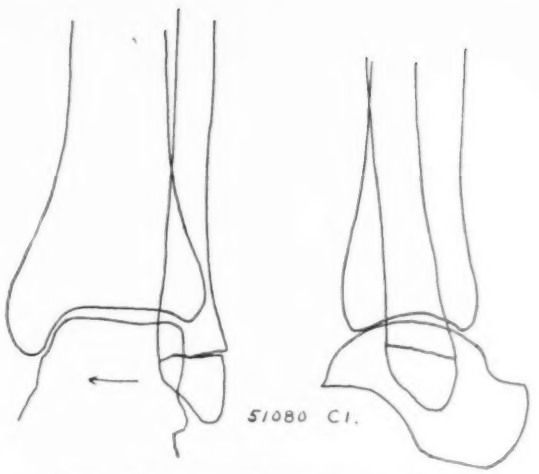

Fig. 15. Adduction fracture, first degree.

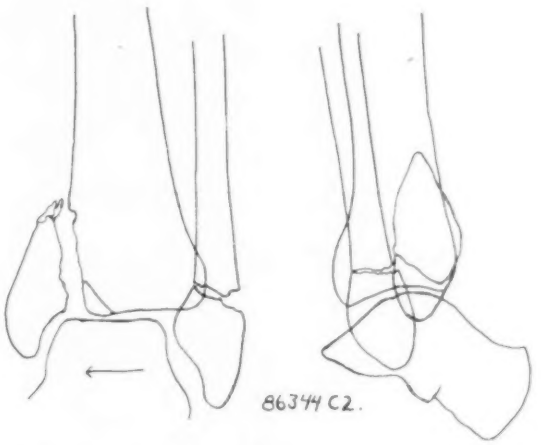

Fig. 16. Adduction fracture, second degree.

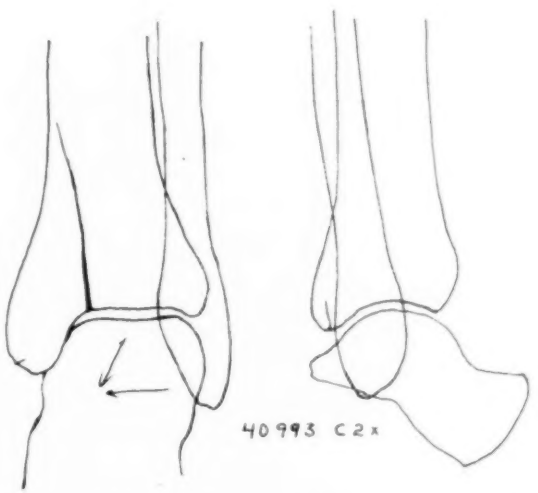

Fig. 17. Adduction fracture, with compression. Isolated vertical fracture of the internal malleolus.

(Fig. 15). This is followed by a crush fracture of the internal malleolus (Fig. 16). This fracture is of a more or less vertical type, depending in degree on the amount of weight of the body forcing the tibia heavily on the displaced astragalus. Such a vertical fracture may occur without an initial fibular fracture (Fig. 17). This mechanism is closely related to the compression type of fracture to be discussed. The third degree of this mechanism, in which the internal malleolus is represented by the whole tibia, is of the supramalleolar type (Fig. 19).

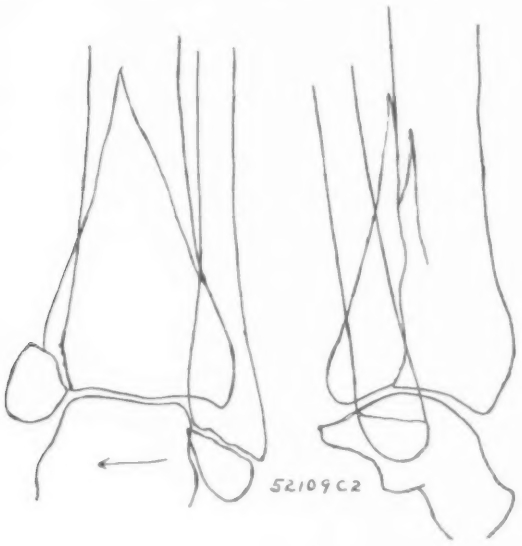

Fig. 18. Adduction fracture, second degree, with large posterior marginal fragment.

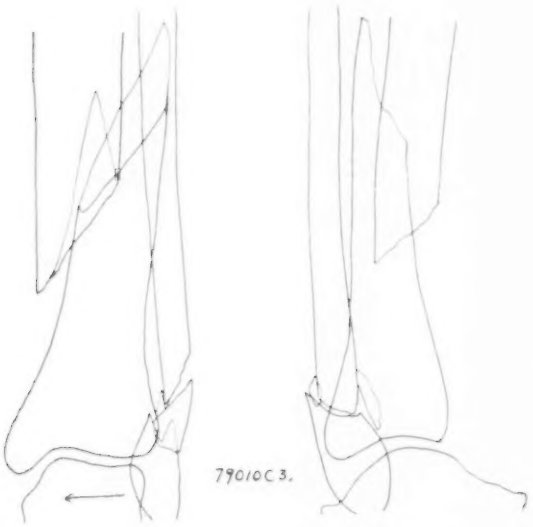

Fig. 19. Adduction fracture, third degree.

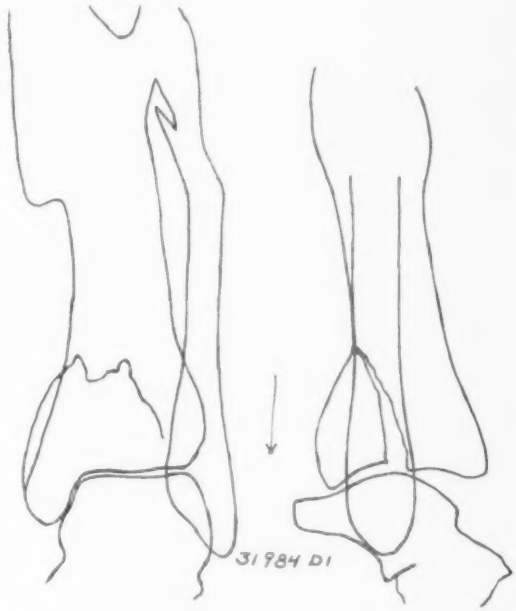

Fig. 20. Compression fracture. Isolated posterior marginal fragment.

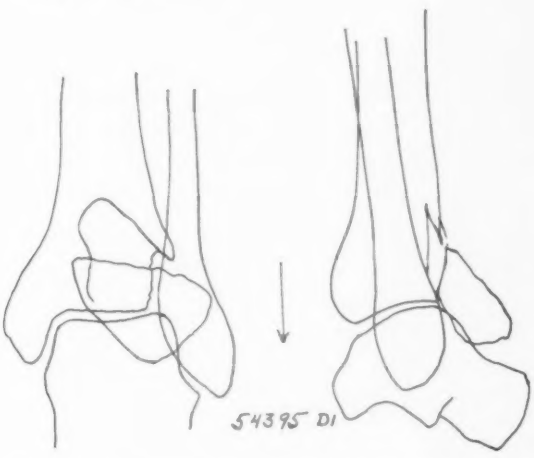

Fig. 21. Compression fracture. Isolated anterior marginal fragment.

Compression Fractures. These are caused by compression in the long axis of the leg, in a manner which is probably very similar to that which more commonly causes fractures of the calcaneus. The simplest form is the isolated posterior marginal fracture

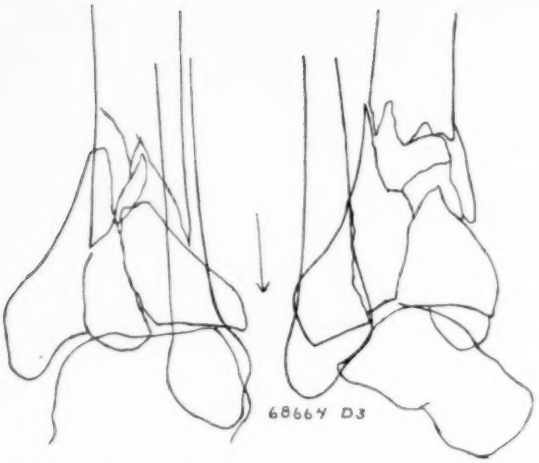

Fig. 22. Compression fracture. Comminution of the tibial plafond.

(Fig. 20) in which a triangular fragment from the posterior aspect of the distal end of the tibia is the only lesion. This fracture has been likened to the Barton fracture of the posterior portion of the distal end of the radius and is caused by a vertical force on the leg with the foot in a slightly extended position; that is, with a slight forward thrust of the tibia.

There is one case in this series in which there is a similar isolated fracture of the anterior portion of the tibia (Fig. 21), which must have been caused by a vertical force acting while the foot was in a slightly flexed position, giving the tibia a slight backward thrust. A third type of isolated fracture by this mechanism is represented by the case of vertical fracture of the internal malleolus (Fig. 19), discussed with the adduction group.

More advanced types caused by compression are the "T," "Y" and comminuted fractures (Fig. 22).

Fractures Caused by Direct Violence. These are of no special importance as to mechanism, being produced in the same manner and having the same characteristics as fractures by direct violence elsewhere in the body (Fig. 23).

Bimalleolar Types. It will be noted that in discussing the second degree of each of the first three mechanisms, a type was described in which there were fractures of both malleoli. Usually there is some characteristic which denotes clearly the causative mechanism; for instance, in the external rotation group the oblique fracture of the external malleolus is characteristic. In the abduction and adduction groups the primary injury is usually denoted by a transverse line of fracture, while the second is either of the crush or vertical type. The number of cases in which the differentiation is doubtful is so small that the margin of error for purposes of classification is negligible, and because of the absence of displacement there is little or no clinical importance in differentiation.

Posterior Marginal Fragments. In addition to the isolated cases which have been discussed under a separate heading, there are a number of cases in which a triangular fragment from the "posterior malleolus" is found as a complication of other fractures (46 cases in this series). Such fragments vary greatly in size (Figs. 13 and 18) and usually remain attached to the external malleolus by the posterior tibiofibular ligament, which is rarely ruptured. They are most frequently associated with the fractures caused by external rotation (Table 1). The presence of a posterior marginal fragment is not necessary to permit posterior displacement of the foot but certainly favors it.

Sprain Fractures. These are frequent as

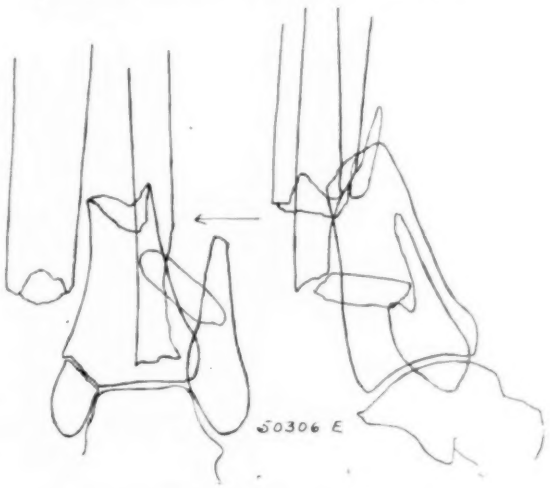

Fig. 23. Fracture due to direct violence.

TABLE I

CLASSIFICATION OF FRACTURES OF THE ADULT ANKLE

	Bishop		Ashhurst and Bromer	
A. Fractures Caused by External Rotation:				
1. First degree: Oblique fracture lower end of fibula only	91	(30.0%)	77	26.0%
a. Isolated fracture anterior tibial tubercle	4		2	
2. Second degree: Same plus rupture of internal lateral ligament or fracture of internal malleolus (low Dupuytren)	62	(22.6%)	100	33.0%
a. Internal lateral ligament uncomplicated	12			
Internal lateral ligament complicated by posterior marginal fragment of tibia	13			
b. Internal malleolus uncomplicated	24			
Internal malleolus complicated by posterior marginal fragment of tibia	24			
3. Third degree: Same plus fracture of whole lower end of tibia	6	(2.0%)	5	1.7%
Total fractures by external rotation	163	(54.4%)	184	60.7%
B. Fractures Caused by Abduction:				
1. First degree: Internal malleolus only	23	(7.6%)	20	6.6%
2. Second degree: Same plus fracture of fibula (transverse, above or below tibio-fibular joint)	54	(18.0%)	41	13.7%
a. Below joint, no diastasis, "bimalleolar"	18			
b. Above joint, with diastasis, Pott's	36			
3. Third degree: Same plus fracture of whole lower end of tibia	2	(0.7%)	2	0.7%
Total fractures by abduction	79	(26.3%)	63	21.0%
C. Fractures Caused by Adduction:				
1. First degree: External malleolus only, transverse, at or below level of tibial plafond	18	(6.0%)	27	9.0%
2. Second degree: Same plus internal malleolus	22	(7.3%)	11	3.6%
3. Third degree: Same plus fracture of whole lower end of tibia	2	(0.7%)	2	0.7%
Total fractures by adduction	42	(14.0%)	40	13.3%
D. Fractures by Compression in Long Axis of Leg:				
1. Isolated marginal fractures	3	(1.0%)	1	0.3%
Anterior marginal	1			
Posterior marginal	2			
2. Comminution of tibial plafond	5	(1.7%)	3	1.0%
3. T or Y fractures	4	(1.3%)	4	1.4%
Total fractures by compression	12	(4.0%)	8	2.7%
E. Fractures by Direct Violence:	4	(1.3%)	5	1.7%
	300	100%	300	100%

TABLE II

POSTERIOR MARGINAL FRACTURES

Associated posterior marginal fragment			46 cases
Low Dupuytren (A 2)	25 cases	54.4%	
Bimalleolar	13 cases	28.3%	
Pott's (B 2)	8 cases	17.3%	
Isolated posterior marginal fractures			2 cases
Total			48 cases, 16%.

isolated osseous lesions, as well as in association with actual fractures. The isolated cases are not included in this series. As complications, they are of importance here as indications of ligamentous rupture. Three types are to be noted—the tip of either malleolus, the anterior tibial tubercle or intermediate fragment (Fig. 4), and the

TABLE III

CLASSIFICATION OF EPIPHYSEAL SEPARATION FRACTURES

A. Epiphyseal Separation Fractures Caused by External Rotation:		
1. First degree: Oblique fracture lower end of fibula, epiphysis separated with diaphyseal fragment	2	
2. Second degree: Same plus fracture or separation of internal malleolus	0	
3. Third degree: Same plus separation of whole tibial epiphysis (posterior diaphyseal fragment in 2 cases)	4	
Total epiphyseal separations by external rotation	6	18.7%
B. Epiphyseal Separation Fractures Caused by Abduction:		
1. First degree: Internal malleolus only	0	
2. Second degree: Same plus external malleolus	0	
3. Third degree: Same plus separation of whole tibial epiphysis	4	
Total epiphyseal separations by abduction	4	12.5%
C. Epiphyseal Separation Fractures Caused by Adduction:		
1. First degree: External malleolus only	3	
2. Second degree: Same plus fracture and epiphyseal separation of internal malleolus	12	
3. Third degree: Same plus separation of whole tibial epiphysis	2	
Total epiphyseal separation fractures by adduction	17	53.1%
D. Epiphyseal Separation Fractures Caused by Compression in Long Axis of Leg:		
1. Whole tibial epiphysis with posterior marginal fracture of diaphysis	4	12.5%
E. Epiphyseal Separation Fracture Caused by Direct Violence	1	3.2%

TABLE IV

COMPARATIVE INCIDENCE OF THIRD DEGREE TYPES

	Epiphyseal Group Separation of Whole Tibial Epiphysis			Adult Group Fracture of Whole Lower End of Tibia		
A. External rotation	4 out of	6	66.7%	6 out of	163	3.7%
B. Abduction	4 out of	4	100.0%	2 out of	79	2.5%
C. Adduction	2 out of	17	11.8%	2 out of	42	4.8%
D. Compression	4 out of	4	100.0%	0 out of	12	0.0%
E. Direct Violence	1 out of	1	100.0%	0 out of	4	0.0%
Totals	15	32	46.8%	10	300	3.3%

posterior tibial tubercle, third fragment of Tillaux. This latter fragment is sometimes confused with a small posterior marginal fragment but does not enter the joint, as does the true marginal fragment.

EPIPHYSEAL SEPARATION FRACTURES

Since first mentioned in the writings of Hippocrates, epiphyseal separations have been a frequent subject in medical literature. Foucher,[4] in 1863, made the first careful study of the pathology of this injury, and Poland,[5] in 1898, published a most comprehensive volume that has been the source of reference in every subsequent paper that I have found.

In all of these articles epiphyseal separations have been spoken of as injuries more or less related to fractures, as are dislocations, but still as a thing apart. This is in spite of the frequency of associated diaphyseal fractures, which are spoken of as complications. Bowen[2] has called these cases, complicated by fractures, "epiphyseal separation fractures," and it is as fractures that I wish to consider 32 cases in which the ankle is involved, and to subject them to the same classification as to mechanism as the group of adult fractures.

The consensus of opinion, as expressed in the literature, is that the almost universal cause of epiphyseal separation is indirect violence, though occasional cases due to direct violence are admitted. Poland divides his cases into groups according to the direction of the displacement of the foot—inward, outward, backward, etc.—and he emphasizes the similarity of the lesions in

Pott's fracture and some cases of epiphyseal separation with outward displacement of the foot. Yet, he expresses doubt that the two conditions are caused by the same force. It is my feeling that we are dealing with lesions produced by identical forces acting on the same structures which, because of incomplete development, react in a slightly different manner. The greatest strain in the epiphyseal cases falls at the junction of the rigid diaphysis and the more elastic epiphysis, the line of cleavage at this point being predisposed to fracture. Each mechanism produces its characteristic lesions, but differing somewhat from the lesions of adult fractures because of these anatomical and developmental differences.

Anatomy. The distal epiphyses of the tibia and fibula are entirely cartilaginous at birth. A more or less centrally located ossification center appears in roentgenograms of the tibial epiphysis at two years, according to Cohn;[3] somewhat later, according to most anatomists, and in the fibula early in the second year. As ossification progresses in these centers, the cartilaginous disc between it and the diaphysis becomes thinner but is maintained by proliferation of the cartilage cells. On the diaphyseal side cartilage proliferation and subsequent bone formation are more active. Here the cartilage is differentiated into several zones—(*a*) resting cartilage; (*b*) proliferating cartilage; (*c*) zone of temporary calcification, and (*d*) the spongiosa or framework marrow zone. This latter layer is soft, spongy and vascular and is the weakest part of the bone. It is the site of traumatic separation, the cartilage being separated, with the epiphysis, from the diaphysis. In older children this zone is extremely thin and separation occurs through true osseous tissue so that, microscopically, even if not macroscopically or roentgenographically, these separations may be considered true fractures. It is in these cases that Werenskiold[8] finds the "lamella" shadow in roentgenograms.

Foucher[4] divided epiphyseal separations into three classes: (1) pure separation of the epiphysis without any osseous tissue adhering to it, a rare type occurring only in the very young; (2) separation of the epiphysis with a thin layer of finely granular, osseous material attached to it; (3) solution of continuity of the diaphysis in the midst of the spongy, osseous tissue near the diaphysis, occurring in instances in which ossification is fairly well advanced, the epiphysis being almost joined to the diaphysis. The presence of an accompanying diaphyseal fragment is a further step in this latter group.

The periosteum is firmly attached to the periphery of the cartilage and, in the young, is thick and is an important factor in holding the epiphysis in place. Later it becomes thinner but retains its attachment so that, with displacement of the epiphysis, the periosteum is stripped off the shaft, usually on the side toward the displacement. This is the usual site of the diaphyseal fragments.

Another frequent lesion is a vertical line of fracture through the epiphysis itself, with separation of that portion on which the force is acting. This type is especially frequent among those cases caused by inward displacement of the foot—adduction, group C.

Influence of Age. Poland states that the purity of the separation, its complication with a fracture of the diaphysis, or the occurrence of a juxta-epiphyseal fracture, will rather depend on the age of the subject than on the character of the violence. For the purpose of roentgenological discussion this group of epiphyseal injuries has been divided, arbitrarily, into three age groups: early—from birth to the ninth year; middle—the ninth to the fourteenth year, inclusive, and late—the fifteenth year to epiphyseal union.

In the early period (the first eight years) epiphyseal separation fractures are rare, the loose, cartilaginous attachment of the epiphysis permitting separation without visible osseous injury. Bowen,[2] in writing of epiphyseal fractures in general, states

that the roentgen diagnosis of epiphyseal injuries under the fifth year is next to impossible in the absence of displacement but that, except in the very young, epiphyseal separation without fracture is very unusual. This is corroborated by others and is my experience. In the early period there are 2 of the 32 cases, one in the third year and one in the sixth.

Werenskiold[8] says that in roentgenograms of good quality such separations can be diagnosed by the detachment of a thin "lamella" from the diaphysis. This lies in the interstice between the epiphysis and the diaphysis and is found in 53 per cent of cases. However, his youngest case is in his eighth year, so that even this sign is of limited value in the early group. The "lamella" is seen in several of this series in the middle age group (Fig. 31).

The middle group (ninth to fourteenth year, inclusive) is the largest. During this period union between the epiphysis and the diaphysis has become progressively more firm, as is shown on the roentgenogram by the, now, narrow, irregular epiphyseal line, and, as a rule, is strong enough to resist separation at some point during a strain, transferring the force to adjacent bone at this point and causing an associated fracture. It is during this age period, I believe, that epiphyseal separation, without fracture, is very rare. Twenty-six of the 32 cases fall in this group, the eleventh and thirteenth years being represented by 6 and 7 cases, respectively.

In the late group (from the fourteenth year to complete epiphyseal union) there are 4 cases—2, each, in the fifteenth and sixteenth years. By this time union, while not complete, is so firm that the epiphyseal line is no longer a weak point, predisposed to injury. In fact, I suspect that, in many cases, it possesses additional strength, as does a firmly united fracture. Certainly photomicrographs suggest this, as do the irregularity of the line and increased density surrounding it on roentgenograms. How else can one account for the rarity of epiphyseal injuries during this period of violent activity, as represented by high and prep school athletics? In fact, we do find that, during this period, the majority of fractures do not involve the epiphyseal line but are either of the juxta-epiphyseal type or of one of the adult types with considerable variation of position of fracture lines, which frequently intersect the epiphyseal line but do not run coincident with it. There are several of this latter type included in our adult group (Figs. 1 and 4). The juxta-epiphyseal type is excluded since it does not involve the ankle proper.

The influence of age is also shown when we consider the types of injury, in that, while epiphyseal separation fractures are caused by the same mechanisms as the adult cases, they occur in a reverse order of frequency. In this adult series 80.3 per cent (Ashhurst and Bromer 82.3 per cent) of the fractures are caused by outward displacements of the foot, external rotation and abduction, while of the epiphyseal separation fractures, only 32.3 per cent are of these types. Furthermore, of the adult cases only 14 per cent of the group (13.3 per cent, Ashhurst and Bromer) are due to adduction, as compared with 54.8 per cent of the epiphyseal separation fractures. It is also to be noted that the patients in the adduction group, on an average, are younger than those in the external rotation and abduction groups.

I believe that this is due to the tendency of children to "in toe." This places the foot in a position predisposing adduction; while with adults there is an almost universal tendency toward pes planus, pronation and "out toe," which just as naturally predispose to outward displacements of the foot.

Three of the cases reported by Bowen on which there are adequate data, confirm this observation—2 of the adduction type at eight years and one due to external rotation at sixteen years.

Ashhurst and Bromer make only passing mention of epiphyseal separation in general (9 cases were excluded in compiling their group but no reference was made to

associated fracture though one such case is illustrated, I believe wrongly, as due to adduction) by stating that the majority of separations of the lower tibial epiphysis are caused by external rotation and, again, that some are caused by abduction. No reference is made to such a lesion being caused by adduction, by which mechanism I find 2 cases with separation of the whole tibial epiphysis and a majority of cases of all types. A comparison shows a striking increase in frequency of third degree cases, there being 14 cases (43.7 per cent) in the epiphyseal group and 10 cases (3.3 per cent) in the adult group.

Frequency. Thirty-two cases of epiphyseal fracture of the ankle are presented in this study. These occurred during the same time interval as the 300 adult fracture cases previously discussed, a frequency of 1 to 10. They are from an active accident service of a general hospital, situated in a thickly populated district of the city, a neighborhood in which race suicide is not a pressing problem.

Deformity and End-Results. None of the cases of this group showed any considerably displacement of the fragments on the original roentgenograms. A goodly number, perhaps even a majority, did have from moderate to gross deformity when first seen by the accident ward surgeon but were corrected, usually without difficulty, before being sent to the roentgen department. Maintenance of the reduction was a frequent problem. It should be noted that the illustrations reproduced here were traced from the first roentgenograms of each case.

Our end-result data are not complete on the series, many of the cases antedating the hospital's follow-up clinic. From the information at hand it would seem that the results are satisfactory. I have found no instance in this group of interference with growth or development, due to epiphyseal injury. We have had one such case recently, following an epiphyseal separation fracture of the radius at the wrist, associated with epiphyseal separation of the ulna which was without displacement at the time of the original roentgenogram. A follow-up examination two years after the injury shows arrested or greatly retarded growth of the ulna, with compensatory bowing of the radius and ulnaward deflection of the wrist and hand. The deformity is sufficient to cause marked impairment of function, and probably will become progressively worse. Smith[6] reports a similar case in which there was arrested development of both ulna and radius.

Smith[7] recently reported 33 cases of epiphyseal separation in which follow-up study was made by roentgenographic measurement in 21 cases, showing that "retarded growth to a slight degree is common," 33 per cent.

The end-results of any reported series that I have reviewed cannot compare with those of Poland, a large percentage of his cases being compound epiphyseal separations. This fact enabled him to make such a detailed study of the pathology of this condition by permitting direct examination of the parts at the time of injury and, in a large percentage of cases, later by dissection after amputation or at autopsy. He expressed the hope that the new "skiography by the method of Roentgen" would aid in the study of these injuries.

Classification. Class A—Epiphyseal separation fractures caused by external rotation of the foot. Six cases, 19.4 per cent, average age, twelve years.

A-1—There are 2 cases showing the initial lesion of this mechanism, an oblique fracture running downward and forward through the diaphysis of the fibula into the epiphyseal line and following it forward to its anterior aspect (Fig. 24). The entire epiphysis remained attached to the diaphyseal fragment. There is no displacement of the fibular fragment and no tibial injury can be seen.

A-2—No cases showing an associated injury to the internal malleolus or its ligament.

A-3—There are 4 cases in which, in addi-

tion to the oblique fracture of the external malleolus, the fracture of the internal malleolus is represented by separation of the entire tibial epiphysis. Two of these

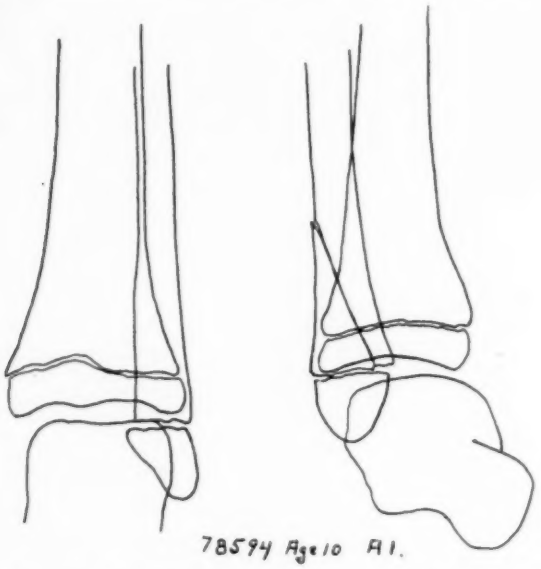

FIG. 24. Epiphyseal separation fracture due to external rotation, first degree.

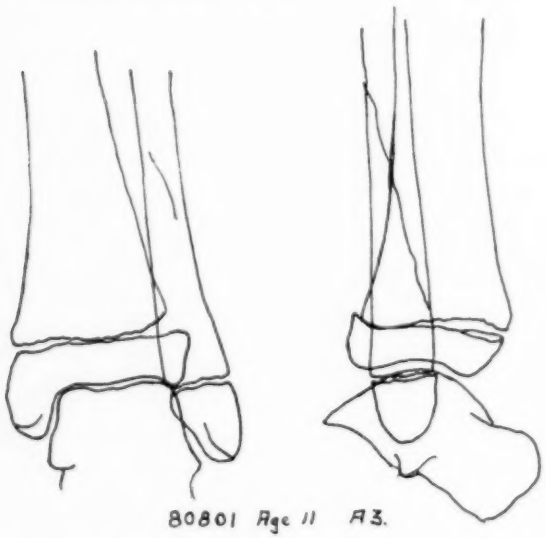

FIG. 25. Epiphyseal separation fracture, due to external rotation, third degree.

cases show no other injury (Fig. 25), two have posterior marginal fragments from the diaphysis of the tibia that remain attached to the epiphysis, and one of these has an intermediate fragment.

Here, again, it should be noted that the frequency of these injuries is opposite to the adult group, being twice as frequent as A-1, whereas, in the adult group A-1 was 15 times as frequent as A-3.

Class B—Epiphyseal separation fractures caused by abduction of the foot—4 cases, 12.9 per cent, three of them averaging thirteen years. (The fourth case is excluded as atypical.)

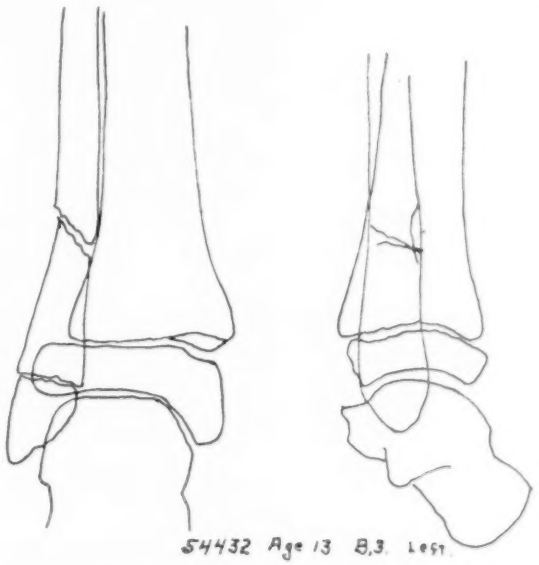

FIG. 26. Epiphyseal separation fracture due to external rotation, third degree.

All of these are of the third degree fracture of the internal malleolus, being represented by separation of the whole tibial epiphysis (Fig. 26). In 3 of these there was a triangular fragment fractured from the anterior and external (fibular) aspects of the tibial diaphysis, which remained attached to the epiphysis. The fourth case was uncomplicated. Three cases showed fracture of the fibula above the epiphysis; the fourth was not fractured, although the lower end of the fibula was displaced outward with the tibial fragment, the lower half of the fibula showing considerable bowing but no visible fracture.

Class C—Epiphyseal separation fractures caused by abduction of the foot—17 cases, 54.8 per cent, averaging eleven years.

First Degree. There are 2 cases in this group, both of them atypical and both well above the average age (sixteen and fourteen). The primary injury in each case is a fracture of the outer portion of the tibial epiphysis, which was caused by the force of the fibular pressure (Fig. 27). These fractures of the tibial epiphysis must have taken place before the fibular injury since, after the fibular injury, the force would no longer be acting on this side of the tibia

Fig. 27. Epiphyseal separation fracture due to adduction, first degree. Note the fracture through the tibial epiphysis with separation of only one fragment.

but would be transferred to the internal malleolus by pressure of the astragalus. This latter action was not sufficient to cause a fracture of the internal malleolus in either of these cases.

Following the crush of the tibial epiphysis the pull of the external lateral ligaments continued forcing the fibula, in one case, against the tibial diaphysis which acted as the fulcrum lever, the power arm of which was consequently lengthened, and a fracture by flexion was produced (Fig. 27). In the other case, the fragment of the tibial epiphysis was not displaced and continued to act as the fulcrum, the fibular injury taking place at the usual level by epiphyseal separation.

Second Degree—13 cases. The primary lesion in 12 of these is separation of the fibular epiphysis and, in one, rupture of the external lateral ligament.

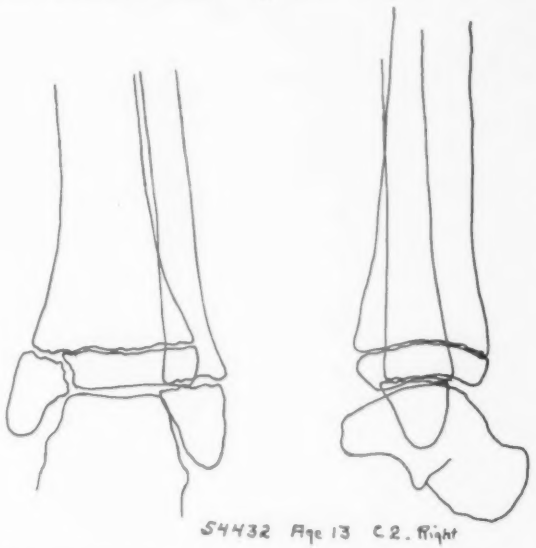

Fig. 28. Epiphyseal separation fracture due to adduction, second degree.

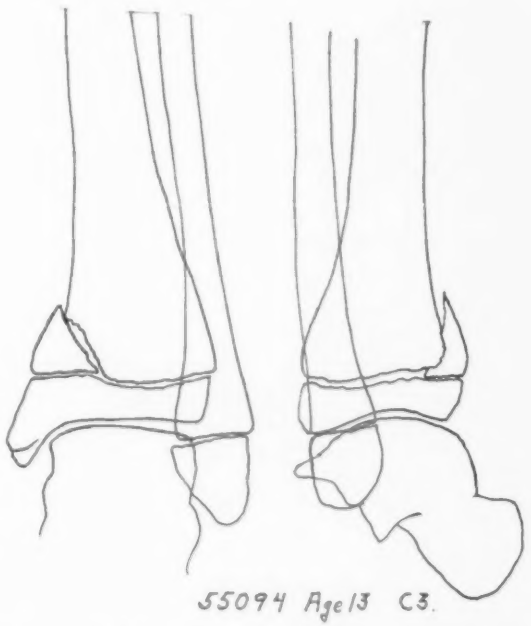

Fig. 29. Epiphyseal separation fracture due to adduction, third degree.

The subsequent injuries to the internal malleoli were likewise strikingly uniform, all of the cases showing a vertical line of fracture running from the joint surface,

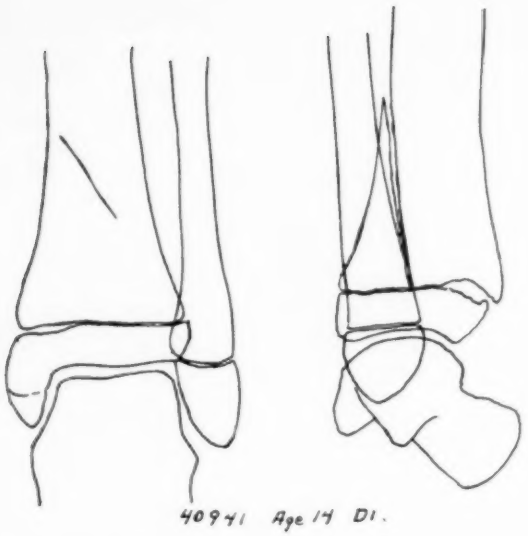

Fig. 30. Epiphyseal separation fracture due to compression. This corresponds to the isolated posterior marginal fracture of adults.

close to the internal malleolus, up to the epiphyseal line and inward through it to its medial aspect (Fig. 28).

Third Degree—2 cases. The first (Fig. 29) is somewhat atypical in that the injury to the tibia must have occurred simultaneously with, if not just previous to, the fibular injury in a manner similar to that described under C. This is, again, not difficult to imagine since we are dealing with a fibula which is still quite flexible and is exerting pressure not against a solid bone as in an adult, but a portion of bone with only a cartilaginous attachment, subject to a lateral shift. It seems that, in this case, fibular flexion caused a slight shift of the tibial epiphysis, the fibula being then pulled against the tibial diaphysis, which acted as the fulcrum, and the fibular fracture occurred just above this level. Continued action of the force, through pressure of the astragalus on the internal malleolus, caused further inward displacement of the tibial epiphysis which carried with it a triangular fragment from the medial aspect of the diaphysis of the tibia.

The second case shows no fibular fracture though there is a slight bowing (this is the youngest patient in the series, aged two years). The whole tibial epiphysis is displaced slightly inward and has carried with it a small triangular fragment from the medial aspect of the diaphysis of the tibia.

Class D—Epiphyseal separation fractures caused by compression in the long axis of the leg, 4 cases, 12.9 per cent. They are the oldest class of the series, averaging fourteen years. This is probably indicative of a more adventuresome stage of the tree-climbing period of life.

These 4 cases present a rather uniform appearance (Fig. 30) and are probably the counterpart of the isolated posterior marginal fracture of the adult type. In each there was backward displacement of the whole tibial epiphysis, which carried with it a triangular fragment from the posterior aspect of the tibial diaphysis. Three of these fragments were quite large, one of them small. They present no unusual problems.

Class E—Epiphyseal separation fracture due to direct violence (supramalleolar type). There is one case, aged thirteen, in this group (Fig. 31) in which a direct force was applied to the outer side of the leg, just above the ankle. There is a bayonet type of greenstick fracture (multiple) of the fibula, with displacement inward to-

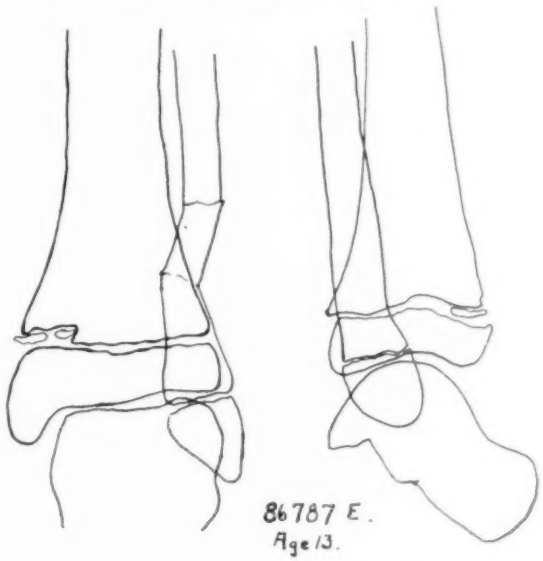

Fig. 31. Epiphyseal separation fracture due to direct violence.

ward the tibia at the point of violence. A continuation of the force against outward resistance has caused an epiphyseal separation, with slight diaphyseal fracture, on the inner side of the tibia.

SUMMARY

1. In the interest of a better understanding of the relationship of various fractures of the ankle, a classification based on the mechanism of such fractures is desirable.

2. The classification of Ashhurst and Bromer is suggested and reviewed as the one of greatest practical value.

3. Three hundred consecutive adult cases are subjected to this classification, with illustrations of the main types and their variations.

4. The influence of age on traumatic separation of the distal tibial and fibular epiphyses is discussed.

5. Roentgenograms are found to be of little value in diagnosing such injuries, in the absence of displacement, before the eighth year, due to the absence of visible osseous injury.

6. After the eighth year epiphyseal separation without osseous injury is rare, and after the fifteenth year epiphyseal injuries are rare, fractures being of the adult type.

7. Thirty-two cases of epiphyseal separation fractures are presented. These are considered as fractures of the ankle in which the line of fracture involves some part of the epiphyseal line, and are classified as to mechanism, each type presenting definite and characteristic features similar to the adult groups.

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DISCUSSION

Dr. E. L. Eliason, Philadelphia. I read this paper of Dr. Bishop's with a great deal of interest and with a great deal of information acquired therefrom. Since the advent of the roentgen ray, we clinicians have been a little bit careless in using what God has given us previously to help us make diagnoses, and our idea in many instances has been to let the roentgen ray make our diagnosis. That is not only true of fractures, but it is true in internal medicine and surgery. That is probably because it frequently saves time and effort. It was my fortune to listen to Dr. White as a teacher, and he taught using your eyes, ears, nose and hands to make a diagnosis. He came before the advent of the roentgen ray and he got a great deal of his teaching material and ability from Sir Frederick Treves. I think Treves' manual on surgery is one of the most interesting books to read.

Those of you who are familiar with Piersol's Anatomy will, of course, be familiar with the practical considerations given in that book by J. William White. They follow out to a great extent the general ideas depicted by Dr. Bishop in his paper. Many times the history of the accident and the mechanism are important. If you are familiar with the mechanism, it will tell you exactly what the roentgenogram is going to tell you when you see it the next day. That is true not only in the ankle, but it is so everywhere else in the body. We know, for example, that if a child in the epiphyseal age falls on the heel of the hand, it is likely to be an epiphyseal separation. It isn't going to be a Colles' fracture. We do not see Colles' fractures

except extremely rarely in the epiphyseal ages. If that child has grown to sixteen or seventeen and falls in the same manner, we are not going to get an epiphyseal separation, we are going to get an adolescent fracture just about two inches above the articular surface of the radius with the carpus. If a man twenty-five, thirty or thirty-five falls on the heel of his hand in the same manner, we are going to get a Colles' fracture. So that understanding the mechanism will help us with the history of the case to make the diagnosis.

If we understand the mechanism and the anatomy of the muscle pull, we are going to be able very easily to make a diagnosis over the telephone of not only the fracture, but of the deformity. Why is that? Because invariably the muscles do certain things if they are uninterrupted by attempts at reduction.

The type of fracture is determined by the mechanism, and by the anatomy and in turn the type of fracture determines the associated complications. For example, if a type of fracture occurs in the ankle, as described by Dr. Bishop, where the sole of the foot is turned out to such an extent that it breaks the mortise open, it is going to mean that certain definite pathological conditions will occur there, as a rule.

Just two other points. I am glad to hear Dr. Bishop talk about the epiphyses because we know, for example, that fracture of the diaphysis following epiphyseal separation occurs at certain ages, and unless we are on our guard to look for it, both clinically and with the roentgen ray, we are going to make a mistake and many times the public will criticize us for not reporting a fracture of the diaphysis, for example, the shaft, when that has been properly replaced and the true significance of the picture has been epiphyseal separation. We have all had examples of that, where the family or the patient himself has entered suit against some friend of ours or even against some of us because the entire picture wasn't presented.

Dr. Bishop speaks of the compression fracture at the lower end of the tibia In adults, a fall on the foot with the foot at right angles to the leg frequently results in os calcis, astragalus fractures and compression fractures of the lower end of the tibia. But for some strange reason, if a child in the teens, early teens, ten, twelve, fourteen, falls on the foot, the line of fracture in the tibia does not become a true compression fracture, but it is a linear one, and it runs out of the articulating surface up the shaft in a linear or spiral manner. Unless we use particular care in taking the roentgenograms of those cases with that history of the mechanism of the fracture, we are going to miss it.

Dr. Ralph Bromer, Philadelphia. Dr. Bishop has presented a subject that is very intriguing, the mechanism of fractures. I want to say that Dr. Ashhurst's classification of fractures of the ankle joint, based on the mechanism of their occurrence, is entirely his own work. I merely assisted him in the roentgen interpretation.

I wish to emphasize the necessity for careful roentgen technique. I believe that Dr. Skinner, fifteen or more years ago drew attention to a practical method of obtaining an absolute perpendicular view by drawing a line through the middle of the tibia. Such a perpendicular view is absolutely necessary in order to determine the exact amount of tibio-fibular separation or diastasis, and the amount of clear space between the internal malleolus and the tibia. The latter is essential in the determination of subluxation of the astragalus. Stereoscopic views are necessary to clearly outline the complication that so frequently occurs, namely, fracture of the posterior lower border of the tibia. the fragment being usually called the posterior marginal fragment.

At the time of presentation of Dr. Ashhurst's classification, the objection was made that it was an elaborate and confusing classification. If a photograph is made of the tracings of the different types and if this be placed by the roentgenologist in close proximity to his viewing table, he will soon be able to recognize with the greatest ease, all the various forms of ankle fractures.

I would like to draw attention especially to the type of ankle fracture that is accompanied by a fracture of the fibula, usually at the junction of its middle and upper third. In these cases more than a mere examination of the ankle joint is necessary.

Dr. George E. Pfahler, Philadelphia. I think this paper and this discussion bring out a very important point which since the days of technicians we are forgetting, and that is we must be clinicians as well as roentgenologists. In other words, we must not be merely picture takers. I find in many of the hospitals, especially, that getting the history of the case briefly before studying it roentgenographically is being

neglected. This discussion shows the importance of not neglecting such clinical evidence.

Dr. Bishop (closing). There is one thing I wanted to emphasize, that in speaking of the mechanism of fractures and in determining the way in which they were produced from the roentgenogram and history, I am not advocating that the roentgenologist diagnose the cause of injury as well as the result, but I do feel that if we understand the logical sequence of these various fractures and their relation to one another, we can give more intelligent and more intelligible reports to the surgeon and guide him perhaps a little more plainly in our reports.

Another thing was about epiphyseal separation fractures. I was primarily interested in the age groups of these injuries. During the first two years, due to the loose attachment of the epiphyseal center, the cartilage being quite wide and loosely attached at that time, there is rarely any osseous injury that we can see on the roentgenogram and in absence of displacements we are unable to diagnose an epiphyseal separation. There are only 2 of these 32 cases in the first eight years of life. From the eighth to the fourteenth year, 26 of the 32 cases occurred. Here the attachment seems to be such that when it separates, a diaphyseal fragment is usually torn away. Then from the fifteenth year on to complete epiphyseal union, in the majority of cases, the line of fracture did not involve the epiphyseal line but intersected it if it happened to be in the way, and the fractures were of the adult type entirely.

DIFFUSE GASTRODUODENAL POLYPOSIS

"EN NAPPE"

By J. EDWIN HABBE, M.D.
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THE following types of essentially benign gastric tumors of the stomach have been described in the literature: leiomyomas, fibromyomas, adenomyomas, hemangiomas, simple myomas, and polyps, single or diffuse. All types are so rare that even the busy gastroenterologist or roentgenologist may not see more than two or three in a lifetime. These benign growths are usually difficult to diagnose clinically, not simply because of their rarity of occurrence but because they may clinically resemble gastric ulcer or cancer, or again they may be clinically silent. The age incidence in a recent series of 23 benign gastric tumor cases reported by Moore at the Mayo Clinic varied from eight years to sixty-nine with forty-four years as the average. Males and females were about equally affected. One rather commonly reported clinical sign is hemorrhage, either in the vomitus or in the stool. The gastric acidity is usually normal or increased, except in diffuse polyposis when the free HCl is almost constantly absent. Although benign tumors have a predilection for the pyloric end of the stomach, gastric retention is uncommon. A palpable mass is rarely recorded except where malignant degeneration has occurred or where carcinoma exists as a separate lesion in the stomach or adjacent organs. It is interesting to note that 4 of Moore's 23 cases were associated with gastric or duodenal ulcer. Adenomatous tumors are rather prone to malignant degeneration.

Considered roentgenologically, benign tumors may at times be recognized as such, although the possibility of malignant degeneration must always be reckoned with and cannot be excluded short of microscopic study, which prompts Rehfuss to the dictum that the treatment of all benign growths in the stomach should be resection. Not only malignant degeneration, but ulceration, hemorrhage, torsion, strangulation, and intussusception may all be complicating factors associated with an essentially benign tumor. Roentgenoscopically and roentgenographically the benign tumor is apt to arise from the wall rather than the curvature, will produce a circumscribed rather than an infiltrating defect in the gastric lumen and will cause little or no disturbance in peristalsis, mobility, or motility.

True gastric polyposis, by which term we mean to exclude the commoner single adenomatous gastric polyp, is unquestionably a rare form of gastric tumor, since probably less than 100 cases have been collected in recent comprehensive reviews of the medical literature of the past few decades. In 69,000 abdominal operations at the Mayo Clinic, 8,000 of which were primarily gastric operations, only one case of gastric polyposis was encountered. Recently another case of this same type was encountered and reported by Moore when he reviewed the records of 23 benign tumors of the stomach seen at the same clinic. The late Dr. Russell D. Carman, who had wide experience and skill in roentgen examination of the gastrointestinal tract, observed only 2 cases—both of which he recognized as such.

Brunn and Pearl, in a recent excellent review of the literature accompanied by the presentation of 5 newly reported proved and 7 probable cases, collected, in all, 79 cases from the past available records. Of the 84 accepted cases it is interesting to note that the first 49 cases reported were in each case recognized only at autopsy, the first one at operation by Wegele in 1909, the first by gastric lavage and tumor washout by Chosrojeff in 1912, the first by the roentgen ray by Carman (reported by Balfour) in 1919, and the first by gastroscopy by Schindler in 1922. In these au-

thors' series are included 8 cases reported between the seven years of 1919–1926 which were correctly diagnosed roentgenologically. Since the publication of Brunn and Pearl's series, 9 additional cases have been reported. It is my belief that probably several times this number have been studied roentgenologically and correctly diagnosed but, because of their isolated occurrence, have not been reported in the literature.

The pathology of gastric polyposis varies with the two types which have been recognized. In the more common type, "polyadenome polypeux," there occurs multiple discrete lobulated pedunculated cystic tumors which on section show a connective tissue stalk with an outer layer of mucous membrane and glandular structures. The rare type, "polyadenome en nappe," consists almost entirely of epithelial hypertrophy which shows grossly well-demarcated nodules not pedunculated or cystic. Only 5 cases of this latter type had been recorded when Strauss, Meyer and Bloom presented 2 proved cases in 1928.

The *etiology* of this rare tumor formation is undetermined. A long-standing atrophic gastritis is advanced by some as an important factor, certainly an associated absence of free hydrochloric acid in the gastric analysis is an almost constant finding, although Mills reported a case in which a partial gastrectomy was done, the specimen on microscopic study showing no evidence of a chronic gastritis, and in Brunn and Pearl's collected series only one-third of the cases showed chronic inflammation. Then there is the congenital theory that polypi originate in epithelial fetal anlagen which are stimulated to growth by chronic inflammatory irritation. Brunn and Pearl believe the polyposis "en nappe" variety may be telangiectatic in origin, although the case here reported was said to show no evidence of telangiectases in the specimen removed for microscopic study. Alcoholism was reported in 8 per cent of their series of cases.

The age incidence of this lesion indicates that it is essentially a disease of advanced life, although 2 cases reported were in patients aged twenty and twenty-one, and in several others the gastric symptoms dated back to the patients' twenties. The majority of cases reported were in males.

The tendency of malignant degeneration to occur is a point that must always be borne in mind and is one which justifies the viewpoints of Brunn and Pearl, Rehfuss, and others, that the treatment of the disease should always be surgical. In the case here reported, the patient's gastric symptoms dated back only a few months, and these could be explained purely on the basis of obstruction and hemorrhage, yet malignant degeneration was manifestly present upon microscopic study of the polyp removed at operation. Finney and Friedenwald reported 2 cases of polyposis, both which showed carcinomatous degeneration, in which symptoms had been present only three and nine months respectively.

The symptoms complained of by the patient with gastric polyposis are not at all characteristic and vary from no symptoms at all to those of carcinoma. Pain is very inconstantly complained of, as are also nausea and vomiting. In Brunn and Pearl's collected series abdominal pain occurred in 28 per cent, diarrhea in 18 per cent, vomiting, anorrhexia and weakness in 17 per cent, and hematemesis in 8 per cent. Only 5 cases were reported as showing obstruction. The case here reported showed a moderate obstruction due either to extension of the polypoid degeneration across the pylorus and into the duodenum as the roentgen findings suggested, or simply to invagination of polyp or intussusception of the prepyloric stomach into the duodenum.

With the symptoms quite variable and indeterminate, the physical findings are equally unreliable except for the indirect findings associated with a secondary anemia. A palpable tumor in the region of the stomach is rarely encountered.

Laboratory evidence is much more constant, although here again it rarely points

strongly to the diagnosis. An increased amount of mucus and an absence of free hydrochloric acid are the two rather constant findings. Two cases of polyp discovered by gastric lavage or by stool examination are reported and such laboratory evidence is indeed valuable in establishing a diagnosis, although it is quite manifestly a rare finding and even when present gives no indication as to the exact location or extent of involvement.

FIG. 1. Rice-containing stomach (courtesy of Dr. P. F. Butler, director X-ray Department, Boston City Hospital). Note rather close resemblance of stomach when barium-meal mixes with undigested rice, to diffuse polyposis, en nappe.

By thorough roentgenologic study, however, we can hope for nearly a 100 per cent diagnosis of all cases, with of course the cases of extensive involvement being usually easiest to recognize and, conversely, the smaller lesions more easily missed except by the skilled examiner. McCullough in 1923 reported a case of single polypus measuring 1 by 2 cm. lying near the pylorus which he recognized by means of the roentgen ray. Occasionally the presence of retained food or vegetable matter or hair-ball will produce a rather similar appearance, except that in such cases it will be noticed that some of the barium passes between the foreign material and the gastric mucosa which results in smooth gastric contour, whereas in polyposis, if the patient is rotated in such a position as to throw the pathological areas of the stomach into profile, it will be noticed that the filling defect encroaches upon the gastric lumen and barium cannot be made to flow between. A case which at first might be confused with true polyposis is illustrated herewith (Fig. 1), the history of which is as follows:

A young Chinese patient who was being studied in the medical out-patient department of the Boston City Hospital was referred to the roentgen department for gastrointestinal study (Fig. 1). The usual instruction to report without breakfast was either forgotten or misunderstood, for upon administration of the barium a peculiar mottled appearance was noted which, upon questioning the patient, was found due to a large bowl of rice which the patient had eaten just prior to reporting for roentgen study. Re-examination on the following morning on a fasting stomach revealed a normal filling of the entire gastric lumen.

At times, as has been indicated in cases reported in the past, the involvement may be so extensive and cause such a gross filling defect as to make it impossible to differentiate from carcinoma, and conversely, a carcinomatous degeneration may be present in a recognized polyposis, yet may not be possible to recognize in the presence of all of the roentgen findings of a benign gastric lesion such as were summarized by Moore, namely, absence of palpable tumor, absence of fixation of stomach, normal progression of peristaltic waves through the involved areas, and smooth-bordered filling defects arising from the wall instead of the curvatures.

With past experiences to reason by, we may thus state that our main hope for a high percentage of correct diagnoses of polyposis, as for all forms of benign gastric tumor, lies in a more routine use of the gastrointestinal roentgen examination, both in the presence of gastric symptoms and when seeking for an unexplained ane-

mia as is done routinely at the Mayo Clinic.

As has already been stated, the treatment of gastric polyposis should be excision in every case because of the tendency (12–20 per cent) for what was originally a benign tumor to undergo malignant degeneration. That the roentgen findings may be those of a benign gastric tumor in the presence of carcinomatous degeneration is shown in the case here reported, and that a carcinoma may be present in some other area than in the region showing polypoid structure is indicated by reports of Menetrier and Mills who each reported a case of carcinoma near the pylorus arising as a distinctly separate lesion with multiple benign polypi present in the media, and by Cameron and Wright-Smith's case whose benign polyposis of the stomach was complicated by a carcinoma of the pancreas. The last-mentioned case also illustrates the additional hazard of fatal hemorrhage from cellularly benign tumors. A most interesting case reported by Miller of polypoid carcinoma showed no evidence of involvement of the deeper structures of the gastric wall, but still showed unquestionable metastases.

CASE REPORT

Mrs. H. K., aged fifty-one, entered Marquette University Hospital, May 25, 1928, on the service of Dr. E. J. Carey, with the complaint of vomiting immediately after eating, which had occurred persistently for a week prior to admission. There was nothing in the family history to suggest carcinoma or other organic gastric disease. The patient's past health had been good and she had never been subjected to operation.

The present illness dated back indefinitely some six or eight months with a gradual onset of painless vomiting of undigested food. Throughout the past winter she had vomited at least once a day, but had never noticed any blood in the vomitus and had not observed tarry stools. Anorexia had developed only in the past month. Deglutition had always been normal. The patient stated that she had lost 40 pounds in five months.

The physical examination revealed a rather poorly nourished anemic woman, not acutely ill. The teeth were in poor condition. The tongue was coated. The neck showed no glandular enlargements. The chest examination was essentially negative. The abdomen was soft. There was no muscular rigidity or tenderness and no definite tumor mass could be palpated. The liver was not enlarged. The blood pressure was 240/128.

The urinalysis showed a 2 plus albumin with occasional granular casts.

Fig. 2. Appearance of stomach and duodenum shortly after administration of barium meal. Seven to eight shallow peristaltic waves starting on greater curvature high in cardiac third were seen. Multiple small defects along both curvatures of duodenal bulb were also noted.

The gastric analysis revealed no free HCl, with a total acidity of 12. Lactic acid was present but the benzidine test for occult blood was negative.

Examination of the feces showed a slight trace of occult blood, otherwise the examination was negative.

A blood count showed 3,300,000 red blood cells, 8,000 white cells, 76 per cent being polymorphonuclears and 23 per cent lymphocytes; hemoglobin was 65 per cent.

The clinical diagnosis was probable carcinoma of the stomach or esophagus.

Fig. 3. Six-hour film with moderate retention shows polyposis to be more extensive than the films of the filled stomach would indicate.

Roentgen examination of the gastrointestinal tract made May 26 and 27 was reported as follows:

"As the barium entered the stomach its upper half was seen to fill smoothly but the media and pyloric portions showed a constant irregular filling. A pronounced hyperperistalsis was noted, the waves beginning very high on the greater curvature with seven to eight waves being seen at a time, but even in the presence of the extensive filling defect, the entire stomach wall appears to be almost normally flexible and some efforts at peristaltic contractions of the prepyloric stomach were noted. The films made of the stomach reveal the nature of the gastric irregularity to be due to numerous small pea-sized filling defects encroaching upon the normal gastric lumen and to be involving the first portion of the duodenum also (Fig. 2).

"At the six-hour examination there was about 40 per cent gastric retention and the media and pyloric portions of the stomach showed the same irregularity of filling noted on the earlier films of the stomach, except that on the six-hour film the lesion appeared more extensive than with the stomach full of barium (Fig. 3).

"The roentgen study of the small and large intestines at the six and twenty-four hour intervals was essentially negative.

"*Conclusions:* The roentgen findings are those of a relatively uncommon organic lesion of the stomach which in this instance involves the middle and pyloric thirds of the stomach and also the first portion of the duodenum. This condition, gastric polyposis, is an essentially benign lesion which at times, however, undergoes malignant degeneration."

The patient was in the hospital under observation until June 4, 1928, during which time she continued to vomit once or twice daily and complained of tiredness and weakness.

On June 4 the abdomen was opened by Dr. F. A. Straton and Dr. E. J. Carey under ethylene anesthesia. The stomach was found free from adhesions and was lifted up into the wound, and on palpation was observed to contain many soft small masses within it which gave it a doughy feeling. The patient's condition did not warrant attempting a gastrectomy so a simple posterior gastroenterostomy was done, and a polyp the size of a large pea was removed from the site of incision of the stomach for microscopic study. There were no enlarged

Fig. 4. Photomicrograph of section of polyp removed at gastroenterostomy, showing: *a*-dilated cystic space; *b*-areas showing rapidly growing glandular epithelium, the cells entirely obliterating the tubule lumen. Occasional mitotic figures were also seen, and several fields showed suggestive invasion of the epithelium into the submucous layer. No telangiectases were noted.

glands discovered or other gross evidence of malignancy.

The patient's postoperative course was never good. On the second day she was irrational and the urinalysis showed a 4 plus albumin with occasional hyaline and granular casts. On the following day there was fecal vomiting although the abdomen was soft and there was little epigastric pain. The following day the patient died of what was diagnosed clinically as secondary cerebral embolism. Post-mortem examination was refused by the patient's relatives.

The microscopic study of the excised specimen was reported by Dr. Grill, the hospital pathologist, as gastric polypus showing definite adenocarcinomatous degeneration. There was no evidence of telangiectases (Fig. 4).*

Comment: In the few cases of diffuse gastric polyposis, en nappe type, reported in the literature, none are described as either roentgenologically or pathologically showing simultaneous involvement of the duodenum. Localized polyps have been reported to have occurred in these regions simultaneously and several cases of diffuse polyposis, en nappe, have shown some duodenal deformity which was never attributed, however, to duodenal polyposis but resembled rather the common lesion, duodenal ulcer. In the case here presented, from close examination of the original films one becomes convinced from the distribution of the polyp shadows along the curvatures as well as in the base of the cap, that this was not a case of gastroduodenal intussusception, in which event a considerable deformity of the pyloric region should be present together with elongation of the pyloric channel, nor was it one of prolapse of a long-pedicled polyp of the stomach into the duodenum, in which case a central filling defect with smooth curvatures of the cap should have resulted. While post-mortem examination of the entire stomach and duodenum was not allowed, this case is presented as one of diffuse polyposis, en nappe, involving both the lower two-thirds of the stomach and the first portion of the duodenum. It is also of interest to note that while both the roentgen and surgical findings were negative for carcinoma yet the pathological study of the single polyp showed definite evidence of malignancy.

* I wish to express my appreciation to Mr. Leo C. Massopust, Marquette University Medical School artist, for the illustrations accompanying this article.

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FIRST OBSERVATIONS ON THE PHYSIOLOGICAL EFFECTS OF ROENTGEN RAYS ON THE HUMAN SKIN*

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IN MY studies on the history of the roentgen rays, I have obtained considerable information regarding the first observations of the effect of roentgen rays upon the human skin.

On February 15, 1896, the *Journal of the American Medical Association* in its first editorial on the newly discovered roentgen rays[1] expressed the opinion that possibly the new rays might have a therapeutic effect. In this editorial, the following statement was made: "As regards their therapeutic possibilities which have already become the plaything of the popular imagination, they may be left to future investigations." Little did this writer know at that time how soon his prophecy would be fulfilled. Unfortunately, the first physiological effects of the roentgen rays were unexpected and undesirable, and they mark the beginning of the long and distressing chapter of the suffering of many roentgen pioneers.

The newly discovered rays could not be expected to produce a physiological effect, therefore the pioneers could see no reason for protecting themselves against them. It is remarkable, therefore, that Roentgen himself made all his experiments with the x-rays in a big zinc box, on the outside of which the tube was placed; later, he even put a lead plate on top of the zinc between the tube and himself. These precautions probably were taken to better define his x-ray beam at will by means of diaphragms in the box and also to protect the photographic plates, with which he made many of his experiments, from being fogged by the rays. At the same time, he himself was completely protected.

Other pioneers were equally careful. Dr. Francis H. Williams, of Boston, one of the best known early roentgen pioneers in this country, has always taken great pains to protect himself against the radiation, from the beginning of his work in 1896 up to the present time, and he has suffered no untoward effects. "I thought that rays having such power of penetrating matter as the x-rays had must have some effect upon the system, and therefore I protected myself," said Dr. Williams to me last year in answer to my question as to what prompted him to exercise caution.

Walter James Dodd, another great American roentgen-ray pioneer and a colleague of Dr. Williams in Boston, did not take such precautions. The result was that his hands were very badly burned by the roentgen rays, and in spite of many operations and skin grafts he died from the effect of these burns in 1916.

The story of these two great men shows how little any physiological effect of the rays was expected in the early days, how little the effect was explainable after it first appeared, and how easy it was to forget the possibility of such effects in the midst of the enthusiasm in working with the newly discovered rays.

Edison, the great inventor, was one of the first to notice some peculiar effects after working with roentgen rays. After several hours' work with fluorescing tubes he would complain of pain in his eyes but he did not think that this was due to the direct effect of the roentgen rays.[2] The New York physician, W. J. Morton, also one of the industrious roentgen pioneers, often saw flashes of light after working with the rays. These after-effects seem to have been of an optical nature, the light of the fluorescing tubes affecting the retina of

* Read before the Cleveland Radiological Society, Oct. 26, 1931.

[1] *J. Am. M. Ass.*, 1896, *26*, 336.

[2] *Nature, Lond.*, March 5, 1896, *53*, 421.

the eye, and probably were not directly due to the roentgen rays. The English roentgenologists, Swinton and Stanton,[3] could not corroborate the observations of their American colleagues.

Soon, however, more definite and more serious reports of undesirable effects of roentgen rays became known. Professor J. Daniel[4] of Vanderbilt University reported in April, 1896, that twenty-one days after taking a picture of the skull of Dr. W. L. Dudley with an exposure time of one hour, he noticed an epilation of a diameter of 2 inches on that part of the head which was directly under the tube.

On March 12, 1896, an Englishman, Dr. R. L. Bowen,[5] in a talk before the London Camera Club, expressed the opinion that roentgen rays might produce a sunburn similar to that of sun rays. At the same time another Englishman, Dr. L. G. Stevens, reported that "those who work with x-rays suffer from changes of the skin which are similar to the effects of a sunburn." Stevens described in his article a case of serious roentgen-ray dermatitis, and from his observations he drew the peculiar conclusion that roentgen rays must also be present in sunlight.[6]

The well-known American scientist, N. Tesla, reported in the *Scientific American Supplement*[7] that "exposure of the head to a powerful x-radiation produces a general soothing effect, a sensation of warmth in the cerebral lobes and a tendency to sleep." He also stated, however, that very often the eyes become inflamed and "that one should not go too close to the tube."

At the 25th Congress of the German Society of Surgery in Berlin, on May 28, 1896, Dr. Feilchenfeld, of Berlin, spoke on "An Eczema Similar to the Eczema Solare, which was Produced by an Exposure of One and One-half Hours to Roentgen Rays,"[8] and a more detailed description of a severe roentgen-ray burn was given shortly afterwards by Dr. W. Markuse,[9] of Berlin, in July, 1896. On account of the general interest in this subject, extracts from Dr. Markuse's article must be mentioned here:

> On July first of this year, a young man seventeen years old, came to my office and showed the effects of frequently repeated experiments for a demonstration with roentgen rays upon the integument. During the past four weeks, beginning with the day on which I saw him first, he was irradiated with roentgen rays every day and sometimes twice a day. When he started the experiments the whole surface of his body was completely normal. Each experiment usually took from five to ten minutes and sometimes a little longer, especially if his thorax was irradiated, since the interest of the observers in the phenomena of the heart pulsation and movements of the diaphragm usually prolonged the time of observation. The distance of the body from the tube was usually 25 cm. in order to obtain clear pictures, but sometimes the body almost touched the tube. The part of his face which was turned toward the tube and which therefore was first struck by the rays showed a diffuse reddening with a brownish discoloration which covered the whole half of his face. The discoloration was darkest at his ear. In some parts of the face scaling, which again was strongest around the ear, could be seen. If one presses with a finger upon the reddened skin the color partly disappears. The sensory reaction on the reddened surface was normal. There never was any itching. The young man first noticed the change in his face two weeks after the beginning of his experiments, when he looked into the mirror. He tried to regain his normal looks by washing his face with vinegar but the only effect was that the skin of the washed part of the face 'came off in large pieces.' The first observation of the changes in his face did not prevent him from continuing his experiments since the reddening, which at that time was not as strong as it was at the time I saw him first, was considered harmless. A few days later, however, the experiments with the young man had to be stopped due to the appearance of the damage on the skin and in the following five days during which I could observe him I could notice a con-

[3] *Nature, Lond.*, March 5, 1896, *53*, 421.
[4] *Science*, April 10, 1896, *3*, 566.
[5] *Lancet, Lond.*, March 12, 1896, *1*, 655.
[6] *Brit. M. J.*, Apr. 18, 1896, *1*, 989: *Science*, May 8, 1896, *3*, 701.
[7] *Scientific American, Supplement*, June 13, 1896, 17053.
[8] *Internat. phot. Monatschr. f. Med. (etc.), Leipz.*, 1896, *3*, 242.
[9] *Deutsche med. Wchnschr.*, July 22, 1896, *22*, 481.

siderable decrease of the reddening of his face. Since then the patient has not come back to see me.

A short report of this case also appeared in the *Electrical Engineer*,[10] the *Literary Digest*,[11] and others. The *Münchener medizinische Wochenschrift*,[12] in a short notice regarding this case, attempted to explain the cause of the skin changes:

The dermatitis, slight burn of the skin and alopecia which were observed on a young man who was used to demonstrate the effect of the x-rays are very likely due to the effect of the high tension currents which go from the tube to the body and probably not to the direct radiation effect.

A few months later, Dr. Markuse[13] made the statement that the case of alopecia which he had reported some time ago showed a complete *restitutio ad integrum* after three months.

A series of similar cases was reported soon afterwards in Germany by Dr. Fuchs,[14] of Charlottenburg, by Mr. O. Leppin,[15] and by Dr. E. Sehrwald,[16] of Freiburg, creating a world-wide sensation. A typical report on the epilating effect of the new rays appeared in the *British Journal of Photography*.[17] This case which had occurred in the United States was discussed in detail. Mr. William Levy, who was given a roentgen examination by Professor Jones, of the Physical Laboratories of the State University of Minnesota, had the following experience:

A picture of his skull was made with a high tension of 100,000 volts. On the next day Mr. Levy began to notice a peculiar effect on his skin wherever it had been most exposed to the rays, and the hair on the right side of his head began to fall out. In a few days the right side of his head was perfectly bald. His right ear had swollen to twice its natural size and presented the same appearance as if it were very badly frozen. Sores were visible on his head, his mouth and throat were blistered so that he could not eat solid food for three weeks, and his lips were swollen, cracked and bleeding. Mr. Levy has recovered from the effects of the rays but still has one-half a bald head. He intends to have the investigations carried further and the bullet removed, but nothing is stated on the subject of hair restoration.

It is interesting to note that after some of the earlier cases of epilation caused by exposure to roentgen rays had been reported, there appeared optimists who at once wished to make practical use of this effect of the roentgen rays. The English *Lancet*,[18] stated jocosely that "if that time that elapses before positive baldness was effected could be reduced, what an incalculable benefit would Roentgen's discovery confer on shavers. Thus to remove the beard would only require the placing of a Crookes tube for a few minutes over the chin before retiring to rest, when next morning the ordinary application of soap and water would complete the operation. Under these circumstances the 'new barber' may not impossibly be one of the many outcomes of the 'new photography.'"

An enterprising Frenchman, Mr. Gaudoin, of Dijon, after reading some of these reports, hurried to Paris intending to make a fortune by applying the discovery.

He was aware that a considerable proportion of his countrywomen are endowed with soft, silky mustaches, which are by no means appreciated by marriageable young girls or even married ladies. He resolved, therefore, to use the roentgen rays as a *dépilatoire*, to remove the superfluous hair from their lips and, when needful, from their chins. Having discreetly made known his benevolent intention, he was not long in securing fair customers. They flocked into his laboratory, patiently waiting their turn, cheerfully paid their fees and received the invisible rays on their full-blown mustaches and incipient beards. But these appendages made no sign of vanishing and some ladies who had been under the treatment asked to have their money back. Mr. Gaudoin appeased these infuriated graces and hurriedly re-

[10] *Electrical Engineer*, Aug. 22, 1896, *22*, 126.
[11] *Literary Digest*, Sept. 5, 1896, *13*, 593.
[12] *München. med. Wchnschr.*, July 28, 1896, *43*, 706.
[13] *München. med. Wchnschr.*, Oct. 20, 1896, *43*, 1021.
[14] *Deutsche. med. Wchsnchr.*, Aug. 27, 1896, *22*, 569.
[15] *Deutsche med. Wchnschr.*, July 9, 1896, *22*, 454.
[16] *Deutsche med. Wchnschr.*, Oct. 8, 1896, *22*, 665.
[17] *Brit. J. Phot.*, Nov. 13, 1896, *43*, 730.
[18] *Lance* , May 9, 1896, *1*, 1296.

tired from the business with the fees he had accumulated.[19]

Reports of more serious damage to the skin caused by over-exposure to the roentgen rays appeared all through the year 1896. In October of that year, J. MacIntyre,[20] the well-known Glasgow radiologist, described a sunburn of his hand caused by roentgen rays, and also more severe reactions on a "demonstrator who was engaged with work on x-rays several hours every day for some months."

Another early victim of the roentgen rays was Dr. H. S. Hawks, of Columbia University, New York City. For many weeks Hawks gave roentgenographic demonstrations in the great department store of Bloomingdale Brothers. He described the roentgen-ray apparatus which he used there in an article in the *Electrical Engineer* as follows:[21]

> To add to the many attractions of their large establishment, Bloomingdale Brothers have recently opened an x-ray exhibition. A few words as to the details of this apparatus may be of interest. The coil is an eight-inch Splitdorf with the make and break circuit mounted on the shaft of a motor, the spark at the break being absorbed by condensers. The tube is of the focusing type and is made by Greiner of this city. By proper manipulation I am able to make a very clear photograph of the hand with 20 to 30 seconds exposure and a picture of the ribs in about 10 to 15 minutes. A very essential thing in running tubes to the maximum effect is to keep the air around them dry. All who are interested in the x-ray should call at Bloomingdale Brothers and see the apparatus in operation.—New York City, September 14, 1896. H. S. Hawks.

The demonstrations lasted for two or three hours every day during which time the apparatus was running continuously. The first effect which Hawks observed was a slight dryness of the skin, which increased and soon resembled a very strong sunburn. He then noticed other symptoms such as the cessation of the growth of the nails on his hands and the scaling of skin in those areas which had been exposed to the roentgen rays. The hair at the temples also disappeared since he had placed his head close to the tube in demonstrating the penetration of the rays to the skull. His eyes were so affected that his vision was impaired. The hair of the eyebrows and eyelashes came out. The chest also showed sunburn-like effects of the radiation. Hawks had to have medical attention in order to relieve his pains. He attempted to protect himself against the disagreeable effects of the rays coming from his tubes by putting vaseline on his hands and using gloves when he was working with the rays. Soon, however, the same effects appeared again to a greater extent. Hawks' case was described in several journals.[22]

Very similar cases were discussed by Dr. G. A. Frei[23] of Boston, by Prof. W. M. Stine[24] of Chicago, and also by an Italian physician who published the report of the roentgen-ray burns of his assistant under the title, "Sad Consequences of Radiation with Roentgen Rays."[25] Stine concluded his report by saying:

> Enough has been so far developed in such connection to conclude that the effects are not due to the x-rays, but rather to ultra-violet rays, which are always present to a greater or lesser extent. It is noteworthy that such effects only result from exposure to the focusing tubes, when owing to the concentration of energy, ultra-violet rays of considerable intensity must be produced.

Frei, on the other hand, believed that only roentgen rays generated with induction coils prove to be harmful, and expressed this belief in an article entitled, "X-rays Harmless with the Static Machine" which appeared in the *Electrical Engineer*.[26] Many other roentgenologists shared Dr. Frei's opinion at that time.

An excellent explanation of the course of

[19] *Brit. J. Phot.*, July 31, 1896, *43*, 493.
[20] *Lancet*, Oct. 3, 1896, *2*, 979.
[21] *Electrical Engineer*, July 22, 1896, *22*, 356.
[22] *Literary Digest*, Aug 1, 1896, *13*, 433: *Electrical Engineer*, Sept. 16, 1896, *22*, 276: *l'Eclairage electrique*, Sept. 5, 1896, *8*, 477.
[23] *Electrical Engineer*, Sept. 16, 1896, *22*, 276.
[24] *Literary Digest*, Dec. 5, 1896, *14*, 145.
[25] *Policlin., Suppl.*, Oct. 17, 1896, *3*, 1006.
[26] *Electrical Engineer*, Dec., 1896, *22*, 651.

a roentgen dermatitis was given by the self experiment of the well-known American investigator and early roentgen-ray worker, Elihu Thomson. Thomson described the effects of the roentgen rays in the following words:

> In some notes on the roentgen rays I have referred to an experiment made to determine the truth in regard to the effect which it had been claimed was produced locally upon the skin and tissues of those subjected for a prolonged period to the radiation from a Crookes tube. I noted the fact that after exposing the little finger of my left hand for one-half hour close to the bulb and about one and one-quarter inches from the bombarded platinum, no decided effect followed until over a week; that finger then reddened, became extremely sensitive, swollen, stiff, and to a certain extent painful. I wish to add that at present about 17 days have elapsed since the exposure and the finger is still quite sore but showing signs of improvement. Two-thirds of the exposed portion is covered by a large blister which becomes larger every day. The effect has not extended through the finger, but is confined to the back and sides and is strictly limited to the exposed portion. The effect on my finger was made in a single exposure of one-half an hour at short distance, and by the laws of inverse squares would be the same as from 10 to 12 hours at six inch distance. I do not think that the effect is electrostatic at all, as has been suggested. The evidence so far as it goes leads me to think that the effect is another indication of the chemical activity of roentgen rays, of like character to the effect of the high-pitch waves of light in causing sunburn, by penetrating more deeply into the tissues. It remains to explain the long "period of incubation" which is peculiar and is akin in effect to the well-known period of incubation in various affections due to disease germs. Here might be the place to issue a caution to experimenters—it is, do not expose more than one finger; be satisfied with the effect of say five hours' exposure at six inch distance, and do not prolong it to equal a longer time, or there may be cause for regret when too late![27]

Thomson's experiment was made with a roentgen tube excited with a static machine and therefore disproved Frei's theory mentioned above.

This warning report again caused other roentgenologists to publish their experiences and to call attention to the dangers of working with roentgen rays. The *British Journal of Photography* collected some of these reports in the following article:[28]

> At an exhibition, Mr. R. C. Bayley showed to visitors his right hand which he had used in demonstrating the x-rays and which had been exposed to a fairly strong radiation for about one hour each day. The exposed hand was distinctly darker in color than the other hand. Mr. J. Spiller had used one of his hands in a similar manner for half an hour at the opening Soirée, and later in the evening, experienced a burning sensation, as if the hand had been scalded. Mr. Wilson Noble mentioned a case in which dermatitis had been induced by an exposure of one hour and a half at a distance of one inch from the tube. Mr. J. Cadett suggested that these and other instances referred to might have arisen from poisoning from platinum salts in handling fluorescent screens. Mr. C. E. Hearson thought the effects in question might be due to decomposition of the water in the tissues of the body, owing to an induced state brought about by the high tension of the currents in the coils, oxygen or hydrogen being sent through according to the direction of the current.

The theories which were advanced at that time regarding the etiology of roentgen-ray dermatitis (according to Kassabian, the Philadelphia radiologist) were: (1) the effect of ultraviolet radiation; (2) the flight of minute platinum atoms from the tube to the skin; (3) the effect of cathode rays; (4) the effect of roentgen rays; (5) electrical induction; (6) ozone generation in the skin (Tesla); (7) idiosyncrasy, and (8) faulty technique.

Another pathetic story of a severe roentgen-ray burn was reported in *Nature, London*,[29] by one, S. J. R., of the X-ray Syndicate, Indian Exhibition, Earl's Court, London. After giving daily demonstrations for about half a year, the writer reported in

[27] *Electrical World*, Nov. 28, 1896, *28*, 666: *Electrical Engineer*, Nov. 25, 1896, *22*, 534.

[28] *Brit. J. Phot.*, Nov. 13, 1896, *43*, 731.

[29] *Nature*, Oct. 29, 1896, *54*, 621.

detail the observations on his hands which ranged from blistering that started about three weeks after the beginning of the demonstrations, up to severe keratosis. He regarded the effect as similar to acute sunburn, with the difference that in the case of the roentgen ray the effect was much more concentrated, "in fact the very essence of it."

Sir Joseph Lister, the great English scientist, who opened the Liverpool Congress of the British Association for the Advancement of Science, in September, 1896, said in his Presidential Address:

> There is another way in which the roentgen rays connect themselves with physiology and may possibly influence medicine. It is found that if the skin is long exposed to their action it becomes very much irritated, affected with a sort of aggravated sunburning. This suggests the idea that the transmission of the rays through the human body may be not altogether a matter of indifference to internal organs, but may by long continued action produce, according to the condition of the part concerned, injurious irritation or salutary stimulation.

Thus, this great scientist, among others, pointed to the future brilliant development of the use of the roentgen rays for therapeutic purposes which was based essentially upon the sad and painful experience of the first roentgen pioneers.

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THE EFFECTS OF ROENTGEN RAYS ON CYTOLOGY AND ABSORPTION FROM EXPERIMENTAL ABSCESSES

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INTRODUCTION

RECENTLY, I[22] studied the cytology and absorption from experimental abscesses at various intervals after their formation. The material used to test absorption from these abscesses was a particulate or colloid, such as graphite and crystalloidal, or true solutions such as phenolsulphonphthalein. The rate of the diffusion of these two preparations through the wall of the abscess was studied by two methods. It appeared that injected materials such as graphite or trypan blue removed mainly by the lymphatic system were well walled off within the abscess cavity at the end of the first day, and did not diffuse through the wall of the abscess until the end of two weeks. When true solutions, such as phenolsulphonphthalein, were used which readily escape into the blood vessels, the blockage was gradually increased until the fourth or the sixth day and then the absorption remained uniformly low for as long as thirty-five days.

This study was undertaken to determine the effect of roentgen rays on these experimental abscesses during the various stages with special reference to the extent of absorption of these colloid and crystalloid preparations.

REVIEW OF THE LITERATURE

The literature concerning the effect of roentgen rays on abscesses and inflammatory processes has increased greatly during the last three years. I shall not attempt to review it completely but shall mention only reports pertinent to this problem.

From a clinical standpoint, the work of Morton and Leddy gives a good description of the subjective and objective changes induced by roentgen-ray treatment of furunculosis. Such lesions must be treated early in order to bring about the most striking results.

The cytologic effect of roentgen rays on inflammatory processes or abscesses depends on the particular tissues involved. It is admitted, for example, that the lymphocytic tissues undergo greater changes from irradiation than any of the fixed subcutaneous elements. Many hypotheses have been evolved concerning the gradations of effects on the various tissues. Two of the most common are the law of Bergonié and Tribondeau, which states that the effects on the various tissues are proportional to their resemblance to embryonic tissue, and the theory of Regaud, which explains the effects as being proportional to the momentary metabolism of cells when irradiated. The theory of Regaud agrees with the fact that the greatest effects are manifested on cells during mitotic division. According to Frola, Maximow and others, the lymphocyte is the most susceptible of the elements of the blood; the polymorphonuclear leucocyte is less susceptible, and the erythrocytes the least injured by roentgen rays. The work of Maximow indicated that, of the fixed tissue elements, the fibroblast is the most susceptible to irradiation, possibly on account of its tendency to undergo mitosis. He further stated that collagen fibrils, a product of connective tissue cells, are decreased in number and considerably coarser. Edema is also marked soon after irradiation and the fluid contains clotted fibrin.

The general effects of irradiation beyond the site of exposure, especially with large doses, are usually manifested by a rise in temperature and a change in the chemical constituents of the blood. Holthusen[13] and Maino explained that these remote changes in tissues are due to a necrohormone, of a

protein nature, which is liberated into the blood stream from the irradiated tissues. The work of Cramer explains that the products liberated from an irradiated area are electively taken up by the reticuloendothelial system the same as colloidal metals and vital stains.

A latent period is always necessary after irradiation for the typical changes to occur. Doljanski, Trillat and Du Noüy explain the latent period as being proportional to the life cycle of cells irradiated.

Many writers, such as Castellino, Dellepiane, and Guerritore, disagree as to whether there is any stimulating action of a 10 to 15 per cent erythema dose. But as Maximow stated, it cannot be proved that the direct effects of irradiation had a stimulating effect on the lymphocytic series. However, there may be a stimulating secondary effect from tissue fluids circulated from an irradiated area on non-irradiated tissues, or on lymphocytes that come into the irradiated area after irradiation.

The clinical experience of Guilbert suggested the possibility of increased absorption following roentgen-ray treatment, for he warned against the indiscriminate use of large doses of radium or roentgen rays for neoplasms in the vicinity of infection. He described a case of fatal septicemia following radium treatment of infected carcinoma of the cervix.

EXPERIMENTAL DATA

Rabbits were used throughout this experiment. For the production of a uniform type of abscess a fresh 8 per cent solution of aleuronat was used. By elevating the skin with the thumb and forefinger the aleuronat was injected into the loose subcutaneous tissues in the region of the loin. The left side was used as the control in each case. Ether anesthesia and surgical technique were used throughout.

Abscesses were produced bilaterally on the right and left loin, and in each animal the right side was irradiated and the left side protected with heavy leaded rubber for a control. Small biopsies were taken bilaterally with ether anesthesia and surgical technique, at various intervals after irradiation and occasionally before irradiation. After taking these biopsies the wall of the abscess was quickly sutured and only a minimal amount of content of the abscess was lost. These biopsies were then put in the various fixatives as required for the various stains.

Dosage of Roentgen Rays Used. The same dosage was used throughout all the experiments reported in this article. The dosage for laboratory animals in terms of biologic effect, as erythema dose for human beings, is difficult to estimate. From the fact that the skin of laboratory animals is much more resistant than that of human beings, it does not necessarily follow that all their tissues are equally resistant. The dosage used was calculated by Desjardins, and was thought to be comparable in effect to about one-fourth to one-half of an erythema dose for human beings. Reddening of the skin or epilation of the shaved regions did not occur.

The voltage was set at 80 kilovolts, amperage was set at 5 milliamperes, the target-skin distance was 40 cm., and the time seven and a half minutes; 1 mm. aluminum filter was used. In irradiating these abscesses, the skin about 2 cm. away from the edge of the abscess was protected with heavy leaded rubber.

RESULTS

Gross Changes. The experimental abscesses, when not irradiated, persisted at about the same size for several months, unless there was superficial necrosis and evacuation of their contents. If the lesions were irradiated, however, one or two days after their formation, there was decided gross evidence of absorption. About the sixth day following irradiation the abscess cavities were practically collapsed. If abscesses were more than a week old when irradiated, little if any decrease in size was visible.

Microscopic Observations. With hematoxylin and eosin stains marked differences

were not observed between the control sections and those irradiated with the dosage previously specified. There were, however, edema and nuclear changes such as karyorrhexis of lymphocytes, macrophages and fibroblasts which were present within the first day or two. In about ten days the collagen fibrils were fewer and much coarser on the irradiated side. With a special stain for reticulum it was evident that these fibers were likewise thickened and fewer in number on the irradiated side. Calcareous and hyaline degeneration was marked in the wall of one four-day abscess, as shown in Figure 1.

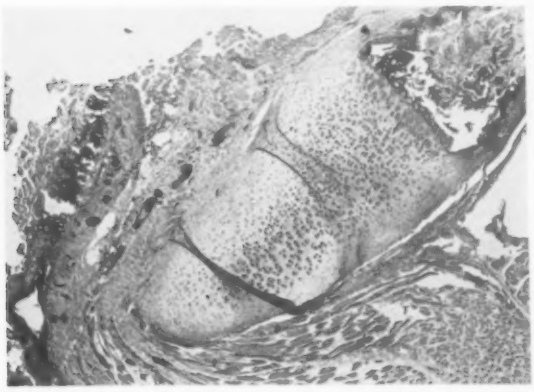

Fig. 1. Four-day stage of wall of abscess, three days after irradiation. Marked hyalinization and some calcification may be seen. Hematoxylin and eosin stain.

In order to determine the changes in absorption induced by irradiation, both abscesses were injected with a preparation of graphite immediately following irradiation of the right abscess. The abscesses were irradiated one day after their formation and sections were taken at necropsy three or four days later. These sections, stained for fibrin with Mallory's phosphotungstic acid stain, revealed on the control side, graphite walled off against the inner pyogenic wall, which partly consisted of a fine network of fibrin (Fig. 2). The corresponding irradiated side showed no definite boundary for the graphite (Fig. 3), and the macrophages were transporting graphite through the inner pyogenic wall. Fibrin

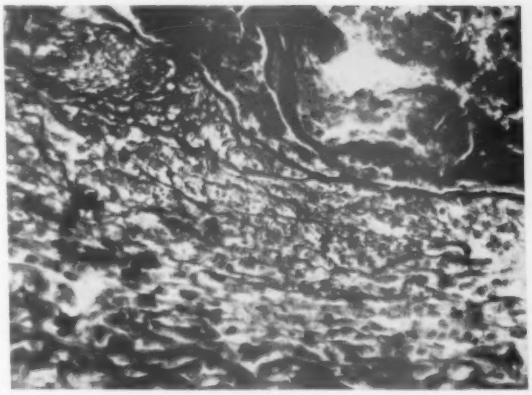

Fig. 2. Four-day stage of wall of control abscess. Fibrin net is shown in inner wall of abscess, but no graphite in wall of abscess. Mallory's phosphotungstic acid stain for fibrin.

also was present in the form of clots but without a fine network.

The effect of roentgen rays on vitally stained macrophages was observed following irradiation of these abscess walls. Abscesses were vitally stained by injecting a 2 per cent solution of trypan blue into their cavities several days after their formation. This produced local vital staining, and after about a week macrophages were well developed. Biopsies were taken on both sides, before irradiation, fixed with solution B of Mitamura and counterstained with a 1 per cent solution of basic fuchsin.

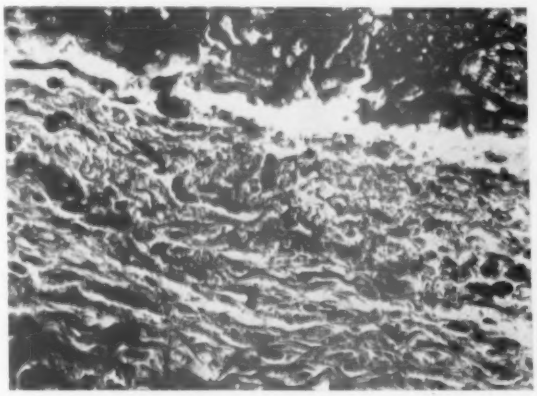

Fig. 3. Four-day stage of wall of abscess, three days after irradiation. Loss of fibrin net is shown and a few graphite laden macrophages passing through wall of abscess. Mallory's phosphotungstic acid stain for fibrin.

After irradiation of the right abscess, daily biopsies were again taken from both lesions.

It appeared that, previous to irradiation, the abscesses on both sides contained numerous vitally stained macrophages. One day after irradiation, however, the macrophages on the right side had almost or totally disappeared, and the staining was

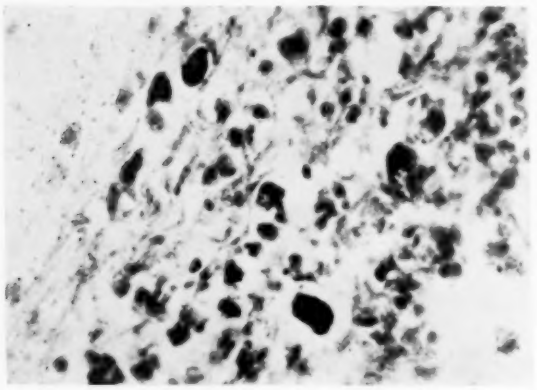

Fig. 4. Thirteen-day stage of wall of control abscess revealing stained cytoplasmic bodies of macrophages. Vitally stained with trypan blue and nuclei counterstained with basic fuchsin.

more diffuse and involved the nucleus as well. In the left or control unirradiated abscess, the vital staining persisted until the fourth or fifth day and then disappeared as on the right side (Figs. 4 and 5).

Absorption and Excretion Experiments. In a previous study of the absorption of soluble materials from cavities of experimental abscesses, it was found that when phenolsulphonphthalein was injected into abscess cavities that the degree of absorption could be determined for various days after the formation of the abscess by a colorimetric analysis of the urine. The results showed a gradual and continuous decrease in absorption from four to six days, after which the amount excreted remained uniformly low at 3 to 5 per cent for many weeks. The same procedures were repeated with either one irradiation the first day after formation or subsequent daily irradiations. The results on absorption were the same as those found in the unirradiated abscesses. One difference, however, was noted. From the unirradiated abscesses, in the stage of low absorption, one or more irradiations would increase the absorption to 10 to 15 per cent and then return to the previous level within three or four days.

COMMENT

While the effect of roentgen rays on living tissues is manifold, this investigation has only touched on a part of the total changes induced. Experimental as well as clinical abscesses, if irradiated early, are reduced in size within a few days, but if irradiated in later stages, they are not nearly so responsive. From this it would be logical to conclude that the absorption of soluble or particulate materials or both has been increased as a result of the irradiation.

It seems evident that in the early stages of an abscess, roentgen rays, whether applied in a single dose, or in daily doses, do not change the usual absorption curve for phenolsulphonphthalein from these experimental lesions. However, if an abscess

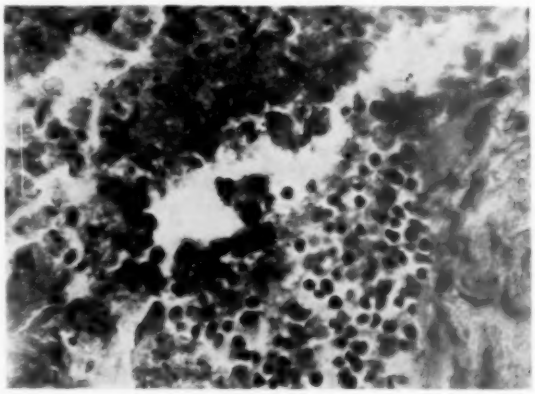

Fig. 5. Thirteen-day stage of wall of abscess, one day after irradiation. Almost complete absence of stained cytoplasmic bodies is shown. Vitally stained with trypan blue and nuclei counterstained with basic fuchsin.

is irradiated during the chronic stages, in single or in daily doses, the absorption may be slightly increased. I believe these results may be explained by the work of Siedamgrotzky, who showed that capillary permeability increases at first but later de-

creases. Therefore the effects of absorption during the early acute stage, when the capillaries were already inflamed and their permeability increased, would be negligible. As Holthusen[14] has shown, resistance would be established, or a radioresistant state to irradiation would develop later.

The effect of irradiation on the absorption of particulate materials, however, is distinctly different in character. As shown by sections, the effect of early irradiation definitely increased the absorption of particulate material. But such an increase was not observed in the later or the chronic stages. These results agree with the conclusions of Cardinale and Maino, according to which the effect of irradiation in acute infections corresponds to specific protein treatment. The increased absorption from irradiated lesions may possibly be due to the evident early digestion of fibrin which has a definite walling off effect before the fibroblastic tissues have established this function. The early digestion of fibrin could be due to ferments liberated from the destruction of lymphocytes and macrophages.

Another degenerative change is shown in the hyalinization and calcification. Domagk has shown that hyalinization of vessels frequently occurs after roentgen-ray treatment. Bell stated that hyalinization and calcification in non-osseous tissues is a degenerative phenomenon.

The entire macrophage system is very susceptible to irradiation, either directly or indirectly. Schönig and Cramer have shown that the activated products of metabolism from an irradiated area are electively taken up by the same system of cells which stores colloidal metals and vital stains. The direct destructive action of irradiation is evident one day after irradiation. The indirect effects are evident by similar changes in unirradiated abscesses four or five days after irradiation. This indirect effect is explained by Holthusen[13] as due to a circulating necrohormone liberated at the site of irradiation.

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SOME EXPERIENCES WITH HIGH ENERGY ROENTGENOGRAPHY

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IMMOBILIZATION is one of the most important factors in the production of satisfactory roentgenograms. The slightest motion either voluntary or involuntary greatly diminishes their diagnostic value. Roentgenographic apparatus would be exceedingly simple in design and operation if it were not for this factor. In addition, by using high energies the kilovoltage peak can be dropped to a certain extent, resulting in more contrast. Holmes, McPhedran, Lawson and Warren were the first to recognize this principle in this country and to use higher energies than were generally employed. Although meeting with considerable success, they were handicapped by limitation of apparatus. Within the past nine months it has been our privilege to use high energies in routine roentgenography with several types of apparatus designed particularly for this work.

Machines designed for the utilization of great power may be classified into two general groups. First, that which derives its electrical energy directly and instantaneously from the supply line. In this group belong the single phase and triphase outfits. The second type operates on a radically different principle. In this instance power is taken from the line to be stored in a condenser which is discharged whenever it is desired to make an exposure. The energy obtained from the line need not be so great but must necessarily continue over a longer period of time. The term high energy will be understood to include all currents over 100 milliamperes.

A modern high energy machine is equipped with valve rectification, using the entire or full wave. The primary line must be adequate regardless of the type of machine used. In the case of the condenser machine this is necessary because of the length of time necessary to charge the condensers, particularly if stereoscopic roentgenography is to be done. Before installing a high energy outfit one should be careful to ascertain that the primary line serving the machine is balanced, of the proper size, and with only a small voltage drop.

The timing of the discharge in high energy work is important. In the single phase outfits it is usually accomplished by synchronizing a motor switch with the alternations (impulse timer). The condenser machine varies the time of discharge by increasing or decreasing the heat of the filament in the roentgen tube on the principle that the discharge time of a condenser is proportional to the resistance of the circuit through which the condenser discharges.

The control of these high energies presents many difficulties and upon the ability of the machine to do this accurately depends its success. Without duplication of results a high energy technique is costly and unsatisfactory. A moment's reflection on the amount of energy which may be used is interesting and instructive. If, for instance, we send 1000 milliamperes through a roentgen tube at 90 kv. peak, we are utilizing 90,000 watts or 90 kilowatts. This power is sufficient to light 3,000 lamps of 30 watt capacity, or, in other words, it represents a horse power of approximately 120. This energy must be accurately measured and passed through the roentgen tube in a fraction of a second. Any inherent defect as regards regulation is magnified many times where large energies are employed. It has been our experience that a well-designed high power roentgen machine is more efficient when operated at lower ranges of energy than a machine designed to do low power work alone.

A milliampere second meter or ballistic meter, preferably not of the condenser

type, is absolutely essential for this work. An exposure long enough to make the usual milliampere meter register would be sufficient to melt the target and thus ruin the tube. It also serves as a check on the accuracy of the timer.

When using large energies great care must be taken to avoid electrical danger, as contact with the high tension line would be very apt to result in a serious accident. The use of a reliable, quick-acting circuit breaker of sufficient capacity is imperative.

We will now briefly outline our experience in regard to the superiority of high energy work over the usual low energy roentgenography.

It is our impression that by using a high energy fast technique of not less than 1/30 of a second we can demonstrate a slight degree of pleural thickening and early apical infiltration. The bases, particularly on the right, appear more distinctly, and not infrequently dilated bronchi are shown. Small amounts of calcification are readily detected in the hilus and mediastinal nodes. The chambers of the heart as indicated by the cardiac outline are more accurately delineated, particularly in the oblique positions. Early pericardial calcification is readily seen and also early calcification of the aorta.

The shadows of the gallbladder appear extraordinarily dense with the oral administration of the dye and fine negative shadows are more clearly seen. We rarely fail to demonstrate some sort of shadow of the gallbladder. If no shadow is seen or it is very faint, a pathological gallbladder is usually found, provided there is no obscuration by intestinal contents. We believe that with this technique intravenous cholecystography is superfluous. Gastrointestinal films are made in 1/10 to 1/40 of a second. This speed eliminates all voluntary or involuntary motion. There is better photographic quality, particularly of the small intestines, which show a wealth of fine detail. This should prove of help in the study of this much neglected portion of the tract.

Delineation of the various muscle groups becomes a practical routine, thus advancing the anatomical study of these structures. It offers a field for diagnosis of muscle tumors, rupture of the muscles, early calcification in hematomas and in muscles, and it also makes possible the visualization of normal blood vessels, especially at the flexures. The very earliest calcification in the arteries can be readily detected. The condition of the deep internal veins in cases of varicose veins in the lower extremities can sometimes be determined, thus aiding the surgeon doing injection therapy.

The advantage of high power in connection with the study of bones is perhaps not so marked except that exceedingly fine periosteal changes may be detected, also it is useful in cases where the part cannot be immobilized. The early study of callous formation is advanced.

More accurate delineation of kidney outlines is possible. In a fair percentage of cases in women before menopause the bladder and uterus can be demonstrated. The ureters, particularly if pathological, can sometimes be seen so distinctly that the plate may be mistaken for a faint intravenous urogram.

The films made using high energy technique have a peculiar sparkle and detail which greatly facilitates diagnosis. The use of an accurately designed high energy roentgen outfit offers to the roentgenologist an instrument whereby his technique may be greatly advanced, opening important new fields and improving on the old.

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THE ROENTGEN DIAGNOSIS OF FETUS PAPYRACEUS IN UTERO

WITH REPORT OF A CASE*

By H. DABNEY KERR, M.D., *and* EDWIN L. RYPINS, M.D.
IOWA CITY, IOWA

ACCORDING to Falls,[4] the roentgen diagnosis of intrauterine pregnancy dates from the report by Albert in 1899, and from that time on, the diagnosis by the roentgen ray of pregnancies both normal and pathological has become a matter of common occurrence. This method is used routinely in a great many clinics where pathological presentations, abnormalities of the fetus, or multiple pregnancies are suspected. Anencephaly was diagnosed ante partum by Case[2] in 1917 and hydrocephalus by Doub in 1925 (cited by Falls). We have been unable to find a reference to the diagnosis of fetus papyraceus by the roentgen ray, although almost every other abnormality has been considered. In Dorland's[3] rather exhaustive works, we find no reference to the roentgen diagnosis of fetus papyraceus, but Schlee[10] in 1911 published roentgenograms of this abnormality taken post partum. Even Hypher,[6] who reviewed the roentgen examinations of about 18,000 suspected abnormal pregnancies and who found many interesting conditions, does not mention fetus papyraceus. This is an indication of its rarity.

Up to 1918, Mosher[7] was able to collect from the literature only 86 cases of fetus papyraceus, which indicates that even pathologically the condition is not common. The first case was reported in 1807 from the United States and 26 of the total cases came from this country.

ETIOLOGY

In double ovum twin pregnancy, one child may die at an early period and be expelled from the uterus soon afterward, while the other may go on to full development. More frequently, however, the dead fetus is retained until the end of pregnancy, and, being compressed between the uterine wall and the membranes of the living child, becomes flattened out and partially mummified (Williams).[15]

Birnbaum[1] agrees with Williams but feels that mummification of the dead fetus occurs much more rarely than maceration. Thus it appears that there develops a monster, not because of any inherent defect in the ovum but because, as Herting (quoted by Schumann[11]) says, "Any human ovum may become a monster and this is not necessarily due to any abnormal conditions of the germ, but to external influences

FIG. 1. Roentgenogram of mother's pelvis before delivery. The first impression was that the mass just under the normal appearing skull was a prolapsed arm, but closer inspection revealed an excessive number of small parts.

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FIG. 2. Photograph of fetus papyraceus.

which affect the growth of the egg." The death of the fetus may be caused by something of which we have no suggestion. Moss[8] reports triplets in which there were two papyraceous fetuses.

REPORT OF CASE

Mrs. L. R., a primipara, entered the University Hospital, May 5, 1931, as a private patient of Dr. E. D. Plass. Patient was in active labor at time of admission, with the presenting part almost on the perineum. Physical examination was negative. Rectal examination did not help diagnose position, so a roentgen examination of the patient's pelvis (Fig. 1) was made. About two hours later, the patient delivered a fetus papyraceus (Fig. 2), followed by a very small, otherwise normal child, weighing 1,322 grams. The mother's Wassermann and Kahn tests were negative. Both mother and child did well and left the hospital in good condition.

DISCUSSION

Diagnosis of fetus papyraceus in this case was not made ante partum but when it was learned that an abnormal condition was present, the possibility of twins differing greatly in size was suggested. However, as Tengbergen[14] states, "The small size of the fetus in comparison with the phase of the pregnancy is suggestive of the death of the fetus." This should have made us suspicious, although Schwaab[12] reports a case of living twins where one was considerably smaller than the other. Examination of the film of the maternal pelvis (Fig. 1) with all the data at hand, reveals quite clearly the mummified fetus lying low in the pelvis, with the living fetus pressed against it. According to Hess,[5] the best way to estimate fetal age is by the appearance of ossification centers. In this case, the fetus papyraceus (Fig. 3) shows centers for the calcanei and sternum which would put the age between six and seven months, although the measured length is only 23 cm. This last

FIG. 3. Roentgenogram of the fetus papyraceus showing development of skeletal system. Ossification centers for calcanei and sternum are just appearing.

would make the age about five months. Hess and Schwaab, however, consider the appearance of ossification centers the best criterion of fetal age.

Examination of the epiphyses of the long bones of the fetus showed changes which were suggestive of congenital syphilis, as described by Pendergrass and Bromer,[9] but the mother's blood examination was negative. This is in accord with the findings of Strachan,[13] who found similar changes present in the bones of non-syphilitic macerated fetuses, and believed them to be due to absorption following death.*

SUMMARY

A case of fetus papyraceus, which can be demonstrated on a roentgenogram of the maternal pelvis, is reported. We have found no reference to the possibility of ante-partum roentgen diagnosis of such a condition.

* We appreciate the courtesy of Dr. E. D. Plass in allowing us to present the clinical findings in this case.

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CALCIFICATION IN SCLERODERMA
WITH REPORT OF A NEW CASE

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TWO extensive catalogues on the subject of scleroderma, one by Lewin and Heller[10] reviewing 435 cases published up to 1894, and the other one by Durham[5] discussing 645 cases reported from 1894 to 1926, give an exhaustive presentation of our knowledge of the disease.

Among the special features of this condition there is one which is very rare, namely, calcification. Thibièrge and Weissenbach[15] collected 9 cases of scleroderma with calcification published up to 1911. Durham[4] reported an additional case and reviewed in the above-mentioned catalogue[5] 13 other cases which appeared in the literature between 1911 and 1928. Thus up to the present time only 23 cases of scleroderma with calcification have been reported, including 3 instances of sclerodactyly.

The rarity of this combination may be a justification for the report of an additional case which was observed roentgenographically fourteen years ago when in an incipient stage, and again recently when in an advanced stage.

REPORT OF CASE

Mrs. L. M., aged sixty-eight, houseworker, had always been well during her adult life until six years prior to her first roentgen examination in June, 1917, when she began to complain of "rheumatic pains," involving intermittently various parts of her body. Approximately five and a half years later the symptoms became localized in both legs and consisted of pain, slight swelling and reddening, and occasional feeling of numbness. It was in this stage that the patient consulted the out-patient department of the Lebanon Hospital and was referred to the roentgen-ray department for an examination of the lower extremities. The roentgenograms showed a few fine calcified spots scattered throughout the upper layers of the middle thirds of both legs (Fig. 1). There was no evidence of any gross pathological bony changes.

FIG. 1. Roentgenogram of both legs, taken fourteen years ago, showing slight calcification of the skin.

FIG. 2. Roentgenogram of both legs, taken recently, showing the increase in the calcium deposits.

The patient was seen again, in private practice, on May 8, 1931, fourteen years later. Both legs presented at this time such a classical appearance of scleroderma that the diagnosis was self-evident. The cutaneous changes involved symmetrically the entire extent of the legs between knees and ankles. On palpation, numerous hard nodules of various sizes were felt. These nodules were evidently very close to the surface. Some of them slightly elevated the skin, others seemed almost to pierce it.

The roentgenogram (Fig. 2) showed evidence of extensive calcium deposits throughout the soft tissues of the involved areas of both legs. Most of these deposits appeared arranged longitudinally in the cutaneous and adjacent subcutaneous tissues, in some places almost reaching the surface of the skin. Bone atrophy, usually found in scleroderma, was not much in evidence in this case. Roentgenoscopy of the chest revealed normal conditions except for a marked left ventricular hypertrophy.

A further study in regard to the location of the calcium deposits and a comparison of both sets of films revealed interesting features which apparently have not yet been described, and which are apt to throw additional light upon the clinical pathology.

Though on rough estimation the calcifying process seemed to be confined to the clinically involved area, careful measuring showed definitely that fine strands of calcification extended beyond that boundary and were seen located underneath perfectly normal skin. Furthermore, roentgenograms taken at various angles proved that some of the smaller calcified spots were situated below the cutaneous tissue elements, in the muscular layers. A comparison of the first with the second findings showed that some of the calcium deposits found fourteen years ago had since disappeared.

COMMENT

According to the published cases, the calcifying process in scleroderma was believed to take place in the advanced, atrophic-sclerosed stage of the disease and to be confined to the cutaneous elements of the clinically involved areas. Where joint regions are diseased the calcification appears very abundant around the joints, which latter not infrequently present roentgen evidence of arthritic changes. What unusual forms and locations the calcium deposits may assume is shown in the very interesting case of Bayless.[1]

Our case furnishes the additional information that the calcification may take place even in the early, edematous stage of the disease in which a clinical diagnosis of scleroderma is practically impossible. This indicates that a severe inflammatory condition sets in early in the disease, possibly even long before any visible skin changes. This is also suggested by the finding, in our case, of calcium deposits underneath apparently normal skin. Early roentgen examinations may therefore occasionally prove an important diagnostic aid.

This point, together with the additional information gained from our case that the calcifying process is not confined to the cutaneous tissues, but also extends into the deep, muscular, elements, would explain why "rheumatism" is such a frequent initial symptom in scleroderma.

These conclusions seem to be supported by the findings of Westphal[20] and Thibièrge[14] who have demonstrated that muscular atrophy in the involved areas of scleroderma should not be explained by inactivity alone, as they found it also in places over which the skin was normal. Furthermore, Méry,[11] Goldschmidt[6] and Dinkler[3] have proved by microscopic examinations that the muscular atrophy may also be due to an observed primary hyperplasia of the interstitial connective tissue. The deep-seated calcium deposits found in our case may therefore have involved such interstitial connective tissue. This would establish a relation between the calcification process in scleroderma and that in interstitial calcinosis, as described, for instance, by Krause and Trappe.[9]

In regard to the theories on calcification, it is well to point out in this connection that, though the ultimate factors deciding its occurrence are not yet known, it is advisable, as I have suggested on previous occasions,[12,13] to adhere to the two main groups of calcification, the dystrophic and the metastatic.

To the dystrophic group belong all those instances where the calcifying process is preceded by a degeneration of the tissue. This group comprises the vast majority of cases. In the by far rarer metastatic form, the calcium is deposited in anatomically normal tissue. The picture of metastatic calcinosis, as first established by Virchow[17] and later confirmed by Versé,[16] Wells[19] and others, is characterized by an oversaturation of the blood with calcium salts showing some extensive bone destructive process associated with chronic nephritis, the latter greatly diminishing the calcium excretion. The calcium in these cases is deposited in the lung, lung veins, endocardium, gastric mucosa, or renal endothelium, but never in the skin. This seems to be supported by the experiments of Hueper.[7]

All the cases of calcification in scleroderma must therefore be classified in the dystrophic group. One cannot agree with Bertolotti[2] who explains the calcification in his case on a metastatic basis secondary to a marked degree of bone atrophy. Nor can one very well agree with Weidman and Shaffer[18] or with Jadassohn[8] who have each published a case of supposedly metastatic calcification of the skin. In the former, preëxisting degenerative changes in a case of osteomyelitis are self-evident from the authors' description of the case. The case of Jadassohn must be considered a combination of a metastatic and dystrophic form. As far as the calcium deposits in the lung, endocardium and kidneys are concerned, the condition is of a metastatic nature. The calcium deposits in the skin, however, must be explained on a dystrophic basis because Jadassohn himself describes other degenerative changes in that portion of the skin.

CONCLUSIONS

Calcification in scleroderma is a rare occurrence. It belongs to the dystrophic group.

The calcifying process may occur in the early, edematous stage of the disease. Roentgen examination may therefore aid in arriving at an early diagnosis.

The calcifying process may not always be confined to the clinically involved cutaneous areas, but may be found underneath apparently normal skin.

It may even reach the deeper, muscular layers. Here it probably involves the interstitial connective tissue.

There is a possibility that scleroderma, dermato-myositis and interstitial calcinosis are the same pathological entity.

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EDITORIALS

PELLEGRINI-STIEDA'S DISEASE

PELLEGRINI in 1905 in the *Clinica moderna* called attention to a traumatic ossification of the collateral tibial ligament of the knee. The same year Köhler reported a similar case, and in 1907 Stieda, in a very comprehensive monograph, unaware of the previous work of Pellegrini and Köhler, again called attention to a semilunar-shaped calcification seen about the superior border of the internal epicondyle of the femur. Pellegrini, in his description of the disease, was under the impression that this ossiffication followed a slight trauma. Stieda, in his report, attributed the condition to fracture with a detachment of a small particle of bone at the moment of injury with subsequent calcification taking place in the ligament.[1] König, Köhler, Pfister and Ewald were definitely of the opinion that the calcification seen in the ligament was a fractureless callous formation and that it was the end-result of periosteal proliferation secondary to a tear of the ligaments and tendons at that point as shown by the fact that the process never appears within less than two to three weeks following the injury.[2] Whether the process is the result of direct or indirect trauma is a matter of some controversy. Most observers on the subject have come to the conclusion that it can be caused by either direct or indirect trauma. The clinical course of the cases is quite similar in that the patient gives a history of a fairly slight trauma and if roentgenographed immediately following the trauma, there is no evidence of dislocation or fracture. However, if the symptoms fail to subside and the patient is examined at the end of about two weeks, much to the surprise of the examiner there will be found a typical semilunar-shaped calcification about the border of the internal epicondyle of the femur, definitely unattached to the epicondyle. This shadow is usually crescent shaped, though it may be somewhat fusiform or elongated or triangular in shape.

The lesions may heal spontaneously and the calcification disappear within a few months, and de Quervain[3] is of the opinion that there is no need for operative interference. It has been observed that if the calcification is removed there is a tendency for it to recur.

Pellegrini-Stieda's disease is of importance from its medicolegal aspect as all the cases reported have been in adults, the injury being sustained while at work, and though the disability of the patient may be considerable at the time, there is a definite tendency for the process to heal and too hasty judgment regarding its permanence is not advisable. With the tendency to spontaneous healing, the conclusions drawn following the beneficial results of roentgen therapy[4] would scarcely seem warranted.

[1] Petrignani, Roger. Etude radiologique de la maladie de Pellegrini-Stieda. *J. de radiol. et d'électrol.*, 1930, *14*, 544–550.

[2] Michelson, Gabriele. Zur Frage der sogenannten "Stiedaschen Fractur." *Röntgenpraxis*, 1930, *2*, 896–898.

[3] De Quervain. Clinical Surgical Diagnosis. Third edition. William Wood and Co., New York, 1913.

[4] Paschetta, Vincent. A propos de la maladie de Pellegrini. *J. de radiol. et d'électrol.*, March, 1932, *16*, 128–129.

DR. GEORGE K. BURGESS

THE *New York Times* of July 3 carries the announcement of the death of Dr. George K. Burgess, internationally known physicist, and for the last nine years director of the Bureau of Standards at Washington. Dr. Burgess suffered a cerebral hemorrhage on July 2 from which he died. He was stricken while discussing certain provisions of the economy bill with staff officials. The economical measures which the government has instituted had been, so the friends of Dr. Burgess said, a considerable source of worry to him since there was in prospect the dismissal of nearly one hundred employees from the Bureau of Standards. For more than a quarter of a century Dr. Burgess had been in the service of this branch of the government and by his ability he had advanced steadily from assistant physicist to the directorship of the Bureau. He was one of the outstanding metallurgists of the country and his work in this field during the world war won him world wide recognition. He was born in Newton, Massachusetts, on January 4, 1874. He received his B.S. degree from the Massachusetts Institute of Technology in 1896 and his Sc.D. from the University of Paris in 1901, the latter with "very honorable mention," the highest commendation given with a doctor's degree. Returning to this country, he taught physics at Technology and later at the University of Michigan, and in 1903 he became an associate physicist at the Bureau of Standards.

Dr. Burgess' activities in the physical field included work on the physics of heat, the radio, aeronautics and tests and specifications of steel rails and car wheels which have lessened the danger of accidents. He directed research in developing rust-proof steel and in learning the properties of gases in steel, and also he conducted tests determining the air pressure on buildings, airplanes, bridges, and other structures. He was a member of many scientific societies throughout the world.

The death of Dr. Burgess serves to emphasize anew the importance of the Bureau of Standards to science and scientific advancement in this country. It is characteristic of the unselfish attitude of men of his type that his death should have occurred at a time when he was making every effort to forestall the possibility of having to dismiss many of his fellow workers in the Bureau of Standards as the result of the enforced governmental economies. Many of the members of the staff of the Bureau of Standards are well known to roentgenologists as they occupy important positions on the editorial boards of their journals and are frequently in attendance at the meetings of their societies at which they contribute papers of great importance, and for the splendid service which they render radiologists in the measurement and standardization of radium and roentgenological equipment. It is to be hoped that those who are in control of governmental affairs will find some way of meeting the present emergency rather than crippling one of the most important branches of governmental research for if, as Lord Kelvin has said, "science is measurement," it behooves the government to maintain its Bureau of Standards at the highest point of efficiency and this can only be done by generous appropriations for that purpose.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Detroit, Mich., Sept. 27–30, 1932.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Milwaukee, Wis., 1933.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Milwaukee, Wis., 1933.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual Meeting: Atlantic City, N. J., Nov. 28–Dec. 2, 1932.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. D. R. MacColl, 2826 S. Hope St., Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Birmingham, Ala., Nov. 16–18, 1932.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401-76th St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio.
Meetings held monthly.

Cleveland Radiological Society
Secretary, Dr. M. A. Thomas, Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.
Next meeting, Jacksonville, November, 1932.

Illinois Radiological Society
Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. M. T. Powers, 250 Genesee St., Utica, N. Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next Meeting: Philipsburg, Pa., May 18–19, 1932.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

*Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.
Next meeting: Richmond, Va., October, 1932.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD-UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

PRELIMINARY ANNOUNCEMENT OF THE PROGRAM FOR THE THIRTY-THIRD ANNUAL MEETING AMERICAN ROENTGEN RAY SOCIETY

Book-Cadillac Hotel Detroit, Michigan
September 27–30, 1932

In arranging this program, special attention is being given to the clinical aspect of roentgenology. Eminent authorities in other fields of medicine are being called upon to bring to our meeting their knowledge of and experience in the several subjects under discussion.

The first half day, which is Tuesday, September 27, will be given over to the consideration of pathology of the joints, and this subject will be presented from various angles by Dr. Ralph K. Ghormley of Rochester, Minnesota, Drs. D. B. Phemister and C. Howard Hatcher, of Chicago, Dr. Maurice M. Pomeranz of New York, Dr. Walter Bauer of Boston, and Dr. Maxwell Harbin of Cleveland, Ohio. This symposium is under the immediate charge of Dr. B. R. Kirklin of the Mayo Clinic.

The second session, on Tuesday afternoon, is to be devoted to the consideration of subjects of special value to those interested in industrial and medicolegal practice. Dr. Howard P. Doub of Detroit has been active in the arrangement of this program and he is to present a paper giving the relation of trauma to arthritis. Dr. L. R. Sante of St. Louis will discuss the subject of "Trauma as an Etiologic Factor in Cardiac and Pulmonary Disease"; "Trauma as an Etiologic Factor in Malignancy" by Dr. F. W. Hartman of the Henry Ford Hospital, Detroit; "Bone Atrophy" by Dr. J. Albert Key, Washington University, St. Louis; "Anatomic Basis for Disturbed Function, Dr. Henry H. Kessler, Newark, N. J.; "Traumatic Neuroses," Dr. L. J. Foster, Detroit; "The Value of Expert Testimony" by Mr. Samuel H. Rhoads, Chairman of the Compensation Board of the State of Michigan.

Wednesday forenoon, September 28, will be devoted to the subject of tuberculosis with special attention to its public health, diagnostic and therapeutic aspects. The physicians of the Department of Health of the City of Detroit will take an active part in this program. Dr. Gordon E. Richards, of Toronto, will present a paper on "The Significance of the Triangluar Basal Shadows in Roentgenograms of the Chest" and Dr. Max Pinner of Tucson, Arizona, will discuss "The Roentgenological Manifestations of Allergic Processes in Pulmonary Tuberculosis."

Wednesday afternoon will be given to the consideration of the uses of roentgenology in gynecology and obstetrics, and the following papers have been arranged for:

Pituitary Function as Related to Certain Uterine Problems, Dr. Robert C. Moehlig, Detroit.

Irradiation in the Treatment of Benign Conditions of the Uterus, Dr. George E. Pfahler, Dr. Jacob H. Vastine, Philadelphia, Pa.

Treatment of Malignancy of the Female Pelvis, Dr. Wm. P. Healy, New York City.

Roentgen Evaluation of Breast Symptoms, Dr. I. H. Lockwood, Kansas City.

Further Cholecystographic Studies in the Late Months of Pregnancy, Dr. Lester Levyn, Dr. Edgar C. Beck, Dr. A. H. Aaron, Buffalo, N. Y.

Results of Therapeutic Intrauterine Lipiodol Injection, Dr. H. P. Cushman, Detroit.

Roentgen Study as an Aid in Obstetrics, Dr. Henry J. Walton, Baltimore.

On Wednesday evening will be given the Caldwell Lecture, by Dr. A. W. Crane, of Kalamazoo, Michigan.

Thursday morning, September 29, will be given over to miscellaneous subjects, among them being "Hypertrophy of the Pyloric Muscle and Duodenitis; Their Association and Roentgenological Manifestations" by Dr. B. R. Kirklin of Rochester and "Roentgen Studies of Pulmonary Atelectasis" by Drs. Willis F. Manges and John T. Farrell, Jr., of Philadelphia.

Thursday afternoon will be devoted to the question of roentgen and radium ther-

apy with a symposium by the Memorial Hospital group, New York City, on "The Relative Effects Produced by 200 kv. X-rays, 700 kv. X-rays and Gamma Rays."

The entire day on Friday, September 30, will be given over to the question of "Malacic Diseases of Bones" and the following subjects discussed under the supervision of Dr. Plinn F. Morse, of Detroit, Michigan:

A. The Clinical Symptomatology of Osteomalacias (including Calcium and Phosphorus Metabolism, Muscular Hypotonia).	
B. Pathologic Classification.	
C. Etiologic Classification (Hereditary, Nutritional, Endemic and Endocrine Factors).	
D. Roentgenologic Grouping	
1. Rickets (Fetal, Infantile, Late)	Dr. Ralph S. Bromer Philadelphia
2. Osteomalacia	Dr. Paul Hodges, Chicago, Ill.
3. Primary Parathyroidism	Dr. E. R. Witwer, Detroit
(a) Osteitis Fibrosa Cystica	Dr. Richard Dresser, Boston
Paget's Disease Leontiasis Ossea Giant Cell Sarcoma	Dr. Cornelius Dyke, New York City
(b) Ankylosing Polyarthritis of Oppel (Strümpell, Marie-Bechterew type) with affections of intervertebral discs	Dr. E. W. Hall, Detroit
(c) Doubtful (Osteopoikilosis)	Dr. L. F. Wilcox Detroit
Marble Bone Disease Kashin-Beck Disease	Dr. A. H. Pirie, Montreal
Renal Rickets	Dr. E. C. Vogt, Boston
4. Osteogenesis Imperfecta (Fragilitas Ossium)	Dr. Ralph S. Bromer Philadelphia
5. Decalcification (in other endocrine disturbances)	
(a) Grave's Disease and Thyroid Deficiency	Dr. Ross Golden, New York City
(b) Diabetes (Islands of Langerhans)	
(c) Pituitary Origin (Basophile Adenoma)	Dr. M. C. Sosman, Boston
(d) Adrenal	Dr. Ross Golden New York City
6. Christian's Syndrome	Dr. Russell Rowland Detroit
7. Cooley's Syndrome	Dr. F. F. Borzell, Philadelphia
Irradiation of the Parathyroids in Cystic Disease of the Bones	Dr. E. A. Merritt, Washington, D. C.

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in St. Paul, Minnesota, on May 23, 1932. Officers for the coming year were elected as follows: President: Dr. Gage Clement, Duluth, Minn.; Vice-President: Dr. Edward Schons, St. Paul, Minn.; Secretary-Treasurer: Dr. Leo G. Rigler, Minneapolis. The following scientific program was presented: Intravenous urography as an Aid in Diagnosis. Dr. G. T. Nordin, Minneapolis; X-ray Treatment of Inoperable Carcinoma of the Breast. Dr. Eugene T. Leddy, Rochester, Minn.; Round Table Discussion of Cases for Diagnosis. Conducted by Dr. J. R. Aurelius, St. Paul; Clinical-Radiological Conference—Diseases of the Chest. Dr. B. R. Kirklin, Rochester, Minn.; Clinical-Radiological Conference, Diseases of the Stomach. Dr. Leo G. Rigler, Minneapolis, Minnesota.

INVITATION TO AMERICAN PHYSICIANS

An invitation has been extended to American Physicians and Surgeons by the Medical Associations of Leningrad, Moscow and other cities of Soviet Russia, to visit their their hospitals, clinics, research laboratories and similar institutions.

This is the first occasion ever offered American physicians to inspect officially these most interesting phases of Russian medical life.

The group of American Physicians which is now forming, will sail this summer.

Those interested can get full information from Compass Tours, 55 West 42nd Street, New York City.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Ultra-Violet Rays and Their Use in the Examination of Works of Art. By James J. Rorimer, Assistant Curator in the Department of Decorative Arts. Paper, price $2.00; cloth, $2.50. Pp. 61, with 47 illustrations. New York: The Metropolitan Museum of Art, 1931.

This interesting book presents the results of three years' experiments on the examination of works of art under ultraviolet radiation. After a discussion of the physical nature of ultraviolet rays and the methods of their production, the author describes the quartz mercury vapor lamp (direct current, 5 amp., 85 volts) and the special filters used in his work (5 mm. red-purple Corning Glass filter, Corex A, 986 A, and Hanau filter). Some of the art objects were examined visually and the rest recorded photographically both under ordinary incandescent light and ultraviolet light. A view camera with an F 4.5 anastigmatic lens and panchromatic plates were used. Works of art of the following materials were examined: Stone (marble, alabaster, limestone, sandstone, granite, precious and semi-precious stones); ivory and bone; ceramics, textiles; prints, drawings and palimpsests; metal, glass, enamel; woodwork and paintings. Observations on these various materials under the influence of ordinary and ultraviolet rays were of definite value to detect restorations and repairs, reproductions, imitations and forgeries. In many cases the ultraviolet rays were the only means of estimating the age of a piece of art and of making small alterations visible. Numerous excellent pictures illustrate these observations. An exposure table for taking photographs of the art pieces under various conditions and a bibliography are given in an appendix. The author shows that the ultraviolet rays have found a definite place in the examination of works of art and successfully supplement other known methods such as chemical analysis, micrography, photography and examination by roentgen rays.

Otto Glasser

A Doctor of the 1870's and 80's. By William Allen Pusey, Sometime President of the American Medical Association and of the American Dermatological Association. Bound. Price, $3.00. Pp. 153, with illustrations. Springfield, Illinois: Charles C Thomas, 1932.

"I have remarked that a true delineation of the humblest man and his scene of pilgrimage through life is capable of interesting the greatest man; each man's life is a strange emblem of everyman's and human portraits faithfully drawn are of all pictures the welcomest on human walls." Thus spoke Carlyle. Dr. Pusey has given us a portrait of his father that is a true delineation of the country doctor and his environment in the 70's and 80's of the last century and an emblem of the better class of rural practitioner. It is a human portrait fairly drawn and therefore a welcome addition to the number of good biographies of country physicians who, yielding to the exigencies of the age, seem to be passing away. Dr. Pusey, the father, practised medicine in a small town in Kentucky and his field of service included a radius of about fifteen miles. We have set forth here his early education as well as his medical training at Jefferson Medical College. There are interesting chapters on the man himself, the manner of getting about, for in a rural community before the days of automobiles and cement roads, transportation was a very important matter, since a large portion of the country doctor's time is spent in the open air. Two chapters give us a splendid account of medicine as it was practised in the seventh and eighth decades of last century, namely, those chapters on Medical Practice and Obstetrics and Surgery. A very thoughtful chapter is that on the appraisal of the life of the subject. The present biography is written with a spirit of detachment that is as rare as it is fascinating. Dr. Pusey's knowledge and experience as a practitioner of medicine has enabled him to enter into the subject of describing the family doctor as exemplified in his father in a way that is not only wholesome but of sustaining interest. Once the book has been begun, the reader is loath to lay it down until he has read the one hundred and fifty-three pages which it

contains. A feature not to be overlooked is the splendid illustrative material which is from the camera of the author. The book is arranged in that pleasing style which has characterized other works by this publisher who has had an eye to the fact that books may have an artistic as well as utilitarian value.

J. H. Dempster

Clinical Roentgen Pathology of Thoracic Lesions. By William H. Meyer, M.D., Professor of Roentgenology in the New York Post-Graduate Medical School of Columbia University; Director of Roentgenology in the New York Post-Graduate Hospital. Cloth. Price, $6.00. Pp. 272, with 183 illustrations. Philadelphia: Lea & Febiger, 1932.

As stated in the preface of this little book, the author has attempted to record in a concise and condensed form the roentgen pathology of thoracic lesions as presented in the basic courses of the Department of Roentgenology of the New York Post-Graduate Medical School. In this respect the author has no doubt succeeded. Taken in conjunction with a series of lectures, the present volume should serve as an excellent guide and outline.

The author has chosen a unique method in the section devoted to the presentation of roentgen pathology. An attempt is made to interpret literally in pathological terms abnormal shadows seen on the roentgenograms. To the reviewer, this was at times quite confusing.

The book is profusely illustrated with many clear and well-chosen roentgenograms. In addition, there are many excellent drawings which add materially to the value of the book. These in many instances compensate for the lack of detail in the text. The section devoted to the technique and especially the emphasis placed upon the importance of gravitational hydrostatic and aërodynamic principles, and the studies in ray projection are distinctly worthwhile.

Karl Kornblum

United States Army X-Ray Manual. Authorized by the Surgeon-General of the Army. Second edition. Rewritten and edited by Lt. Col. H. C. Pillsbury, M. C., U. S. A. Bound. Price, $5.00. Pp. 482, with 228 illustrations. New York: Paul B. Hoeber, Inc., 1932.

Army manuals have always been emphatic in brevity, and not especially decorative in style, but with every sentence present for a definite purpose. This member of the family is true to tradition. And for those who have laid away, as somewhat out of date, the former manual prepared under wartime pressure, this new edition will prove refreshingly modernized. An introductory chapter on electrophysics, only sufficient to lead the reader into an understandable discussion of apparatus construction and operation, is very satisfactory in its brief thoroughness, permitting the civil practitioner as well as the military surgeon to use the manual as a guide in practical trouble-shooting.

Necessarily in so compact a volume, roentgen interpretation is not exhaustively treated, but this section presents a surprisingly thorough outline of what may be expected of the roentgen examination in the diagnostic field, together with an indication of the proper additional differential aids. New illustrations together with numerous diagrams illuminate the text.

The author in his preface calls the manual "a condensed description that covers apparatus, technic and interpretation." "Condensed" it is, yes, but it "covers" its purpose so satisfactorily as to make it an excellent handbook for the beginner in roentgenological diagnostic work. Teachers of roentgenology would do well to consider this work when selecting a textbook for medical students and beginners in postgraduate roentgenological work.

James T. Case

Normale und pathologische Funktionen der Verdauungsorgane im Röntgenbild. Von Dr. Rudolf Becker, Röntgeninstitut des Theresienkrankenhauses, Mannheim, and Dr. Albert Oppenheimer, Röntgenabteilung der Med. Universitäts-Poliklinik, Frankfurt a. M. Paper, price M. 16.75; bound M. 18.75. Pp. 144, with 255 illustrations. Leipzig: Georg Thieme, 1931.

This book deals with gastrointestinal physiology as it can be made manifest by roentgen methods. The "function" of any part of the digestive canal, as considered by the writers, is expressed in its form, tone, movements and in the rate at which it propels its contents caudally. From the act of swallowing to defecation, the normal activities of the various divisions of the alimentary tract are discussed, as well as the pathological processes and other influences,

such as drugs, which modify them. The esophagus, the stomach, the small intestine, the large intestine and the gallbladder are taken up in separate sections and at the end the normal motility rates are summarized. Much of the material is apparently based on the authors' experience. The bibliography is not large; the work of Alvarez is not mentioned.

In their discussion of this phase of gastrointestinal roentgenology, the writers go into great detail. For example, they recognize three main and five subtypes of constipation. They describe hyper- and hypotonicity of the gallbladder. To stimulate gallbladder contraction they give the yolk of one egg and take films ten, thirty and sixty minutes later. By this means they demonstrate hyper- and hypoirritability of the gallbladder, and reproduce films from two cases in which such pathological physiology was set right by a Karlsbad "cure" or otherwise. The density of the gallbladder shadow as an expression of the concentrating function of its wall is not discussed.

In this book is assembled much interesting information but one must overlook certain vagaries of the sort just mentioned.

Ross Golden

Books Received

Pulmonary Tuberculosis. By Maurice Fishberg, M.D., Chief of the Tuberculosis Service, Montefiore Hospital, and of its Country Sanatorium for Incipient Tuberculosis. Volumes I and II. Fourth edition, thoroughly revised. Cloth. Price, $15.00. Pp. 1191, with 232 illustrations and 8 plates. Philadelphia: Lea and Febiger, 1932.

California's Medical Story. By Henry Harris, M.D., Associate Clinical Professor of Medicine, University of California; Chief of Medical Department, San Francisco Polyclinic. With an Introduction by Charles Singer, M.D., D.Litt., University of London, London, England. Bound. Pp. 421. Printed by the Grabhorn Press for J. W. Stacey, Inc., San Francisco, 1932.

The Heart Rate. By Ernst P. Boas, M.D., Associate Physician, Mt. Sinai Hospital, New York City, and Ernst F. Goldschmidt, Ph.D., Research Fellow (1930–1931), Department of Surgery in the Yale University School of Medicine. Cloth. Price, $3.50. Pp. 166, with 68 illustrations. Springfield, Illinois: Charles C Thomas, 1932.

The Sign of Babinksi: A Study of the Evolution of Cortical Dominance in Primates. By John F. Fulton, Sterling Professor of Physiology in the Yale University School of Medicine, and Allen D. Keller, Professor of Physiology and Pharmacology in the School of Medicine, University of Alabama. Cloth. Price, $5.00. Pp. 165, with 65 illustrations. Springfield, Illinois: Charles C Thomas, 1932.

A Text-Book of X-Ray Therapeutics. By Robert Knox, M.D., C.M., Edin,; M.R.C.S., Eng.; L.R.C.P., Lond. Completed and edited by Walter M. Levitt, M.B., Irel.; M.R.C.P., Lond.; D.M.R.E., Camb., Medical Officer in Charge of the Radiotherapeutic Research Department and Assistant Medical Officer to the X-ray Department, St. Bartholomew's Hospital, London. Cloth. Price, $7.00. Pp. 250, with 95 illustrations and 11 plates and 1 colored plate. New York: The Macmillan Company, 1932; London: A. & C. Black, Limited.

Electrosurgery. By Howard A. Kelly, M.D., LL.D., F.A.C.S., Baltimore, Maryland, and Grant E. Ward, M.D., F.A.C.S., Baltimore, Maryland. Cloth. Price, $7.00. Pp. 305, with 382 illustrations. Philadelphia and London: W. B. Saunders Co., 1932.

Ultra-Violet Rays and Their Use in the Examination of Works of Art. By James J. Rorimer, Assistant Curator in the Department of Decorative Arts. Paper, price $2.00; cloth, $2.50. Pp. 61, with 47 illustrations. New York: The Metropolitan Museum of Art, 1931.

Exploration radiologique de l'appareil respiratoire. Fascicule I and II. Par Émile Sergent, Professeur à la Faculté de Médecine de Paris, Membre de l'Académie de Médecine, Francis Bordet, Ancient Chef de Clinique de la Faculté de Médecine de Paris, et Henri Durand, Chef du laboratoire de la Clinique de la Charité, avec la collaboration technique de J. Couvreux, Chef du laboratoire de Radiologie de la Clinique de la Charité. Cloth. Price, 350 fr. Pp. 465, with 639 illustrations. Paris: Masson et Cie, 1931.

Röntgendiagnostik des Schädels bei Erkrankungen des Auges und seiner Nachbarorgane. Von Dr. Rudolf Thiel, a. o. Professor der Augenheilkunde an der Universität Berlin, Assistent der Universitäts-Augenklinik, Berlin. Paper, RM 48.00; bound, RM 54.00. Pp. 87, with 411 illustrations. Berlin: Julius Springer, 1932.

Das Jahrhundert der Strahlen: Ein gemeinverständlicher Überblick über das Wesen und die hohe Bedeutung der verschiedenen Strahlenarten. Vortrag gehalten im Deutschen Museum zu München am 27. Mai 1929. Von Dipl.-Ing. Dr. phil. Josef Rosenthal, München. Paper. Price, RM 2.25. Pp. 29, with 18 illustrations. Leipzig: Georg Thieme, 1930.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

BOGIN, MAXWELL, HOLZSAGER, THEODORE G., and KRAMER, BENJAMIN. Encephalography in children. *Am. J. Dis. Child.*, Sept., 1931, *42*, 526–543.

The authors report their experience of ten years with encephalography, presenting 20 cases of its use in children. Seven of the cases are reported in detail with illustrative roentgenograms. They first give a brief historical review and then describe their method, which is essentially the same as that previously described by Crothers. In the discussion of the amount of air injected and fluid removed, they state 60 to 120 c.c. of air will afford adequate visualization in most cases. They cite one case of encephalitis following varicella in which encephalography by the lumbar and suboccipital routes was attempted. Only 30 c.c. of fluid could be withdrawn in each instance. When a similar amount of air was injected only the cortical markings were portrayed in the roentgenogram. It was suggested that the cerebral foramina were being temporarily blocked by reactionary edema which might be reduced by cerebral dehydration. This was accomplished by intravenous injections of hypertonic solutions of dextrose and magnesium sulphate, and at subsequent encephalography, 130 c.c. of spinal fluid was removed and about 120 c.c. of air injected. Normal ventricles were visualized.

They have found no ill effects from having roentgen investigation started immediately after the air injection. They recommend that it be started with roentgenoscopy. This gives valuable information as to the degree, absence or asymmetry of the filling, and can frequently spare an entire series of exposures by showing an unsatisfactorily filled hydrocephalus. By manipulation of the patient's head in some cases, one may effect better distribution of air in the fluid pathways. A clearer tridimensional concept of the ventricular system may also be obtained in this fashion and the various shadows traced to their counterparts in the four views. Stereoscopic exposures are part of the routine roentgenography. They emphasize the exercise of great care in the performance of the entire procedure in order to minimize sequelae. Headache may occur; likewise, vomiting, shallow respiration, perspiration and pallor. During the escape of the fluid, bradycardia sets in, but it disappears with insufflation of air. Severe collapse is very rarely observed. Increasing drowsiness sets in toward the close of the procedure and persists for several hours. The temperature usually rises to 100.5 F., several hours after the injection and gradually subsides. In isolated cases meningitic symptoms may supervene, the spinal fluid showing evidences of an aseptic meningitis. As a rule, young children tolerate the procedure well, frequently sitting up and playing in bed, several hours after the injection. In hydrocephalic persons in whom a reactionary hypersecretion has occurred, intravenous hypertonic solutions and repeated lumbar punctures have been of value in relieving the symptoms. They believe that encephalography has considerable therapeutic value in epidemic meningitis in that it lessens the tendency to the formation of adhesions. Amelioration of symptoms in epilepsy for several weeks or months is not infrequent. Recalcitrant, as well as post-traumatic headaches have yielded to the insufflation of air. In a case of Little's disease, disappearance of spasticity has been noted during the time the air remained in the ventricles. In acute and chronic encephalitis, on the other hand, aggravation of symptoms has occasionally been noted.

An understanding of the anatomy and physiology of the channels of the cerebrospinal fluid is essential for the proper interpretation of roentgenograms in encephalography. The authors describe the normal appearance and also some of the variations from normal. They state that encephalography is of most value in children in showing pathologic intracranial conditions in infantile birth palsies, congenital malformations of the brain such as microcephalia and porencephalia, congenital internal hydrocephalus and tuberculous and purulent meningitis.

They report 20 cases. Of these, 4 were patients having meningococcus meningitis, 3 showing normal encephalograms, the other case showing marked generalized ventricular dilata-

tion, apparently due to a temporary hydrocephalus. Five cases of cerebral maldevelopment demonstrated intracranial disease, in vivo, in the roentgenogram. One showed a definite porencephalia on the right side. Another showed hemiatrophy of the cortical brain substance and irregular deformity of the ventricles. The third case showed deformity of the skull and ventricles, being a case of microcephalia and status epilepticus. This patient had a severe reaction and died thirty-six hours after the air injection. The other two cases of maldevelopment showed excessive cortical markings incident to shrinkage of the brain with porencephalia of the frontal lobe. The series also included 2 cases of birth injury, both of which showed mild hydrocephalus, one having an absence of ventricular filling though cortical markings were present. Of 2 cases of abscess of the brain, one showed deformity of the homolateral ventricle with definite displacement of both ventricles to the opposite side. Operation confirmed the diagnosis. The case of tuberculous meningitis showed slight generalized hydrocephalus. Two cases of epilepsy showed normal roentgenograms, the same being true of 2 cases of encephalitis. In one patient a diagnosis of brain tumor was made but this was not verified as no post-mortem examination was permitted. One case of communicating hydrocephalus is also included in their series.

In their summary, they conclude that encephalography, although not without its contraindications and dangers, has proved to be of definite value in the differential diagnosis of many intracranial conditions and the exact localization of some of these. In that it can reveal gross anatomic lesions, it is of distinct value to pediatricians and neurologists, especially in their consideration of prognosis. Therapeutic applicability has been demonstrated in some neurologic disorders.—*R. S. Bromer.*

Johnston, W. H. Mastoiditis in infants; a review of the literature with summary of cases studied. *Ann. Otol., Rhinol. & Laryngol.*, Dec., 1931, *40*, 1115–1138.

The author reviews the literature and adds a group of cases studied at the Washington University, School of Medicine. He concludes that the so-called gastrointestinal mastoiditis syndrome does exist. The diagnosis is best made through repeated otological examinations. Bulging of the posterior portion or Shrapnell's membrane, loss of landmarks, or a change in color are most common evidences of otitis media. The pus is often too thick to bulge the membrane. There is no objection to exploratory puncture or myringotomy. The mastoid rarely shows objective inflammatory changes. There is great individual variation in the size and shape of the antrum. The greatest advantage of roentgen examination lies in localizing the antrum and in following the changes that occur from day to day. He quotes Evans, Martin, Carmach, and Granger as to the value of the roentgen ray in diagnosis. The author considers operation indicated in all cases that do not respond promptly to myringotomy. He outlines his operative technique in considerable detail.—*E. I. L. Cilley.*

Taylor, Henry K. The roentgen findings in suppuration of the petrous apex. *Ann. Otol., Rhinol. & Laryngol.*, June, 1931, *40*, 367–392.

About 37 per cent of petrous pyramids are identical in structure to the mastoid processes. The most useful information is obtained from a base plate, which shows the surrounding bony structure and opposite pyramid for comparison. The oblique positions give a better outline of the pyramid. The author's routine includes stereoscopic mastoids, a base plate, and anteroposterior oblique projections of both pyramids.

Technique: Base plate, patient supine on table, head rests on vertex such that a line through the auditory meatus and superior orbital margin is parallel to the table. The tube is tilted 15° to 20° upward so the central ray is in the median line, one inch in front of the auditory meatus. For the oblique views, the head is rotated 45° to the left for the right side and vice versa. The chin is pulled in; as in the base plate, the film is horizontal. The central ray is perpendicular to the film, and passes through 1 inch above the external angle of the uppermost orbit.

Diagnosis: A slight diminution in aeration is noted, in the petrosa, in acute purulent otitis media or mastoiditis due to congestion of the lining membrane. One of the earliest findings in suppuration of the apex is a marked diminution in aeration with a loss of trabeculation. This is followed by a decalcification or atrophy of the apex, the contour remaining intact. This decalcification extends from the apex laterally

and ends rather abruptly medial to the labyrinth. The basal portion shows a relative or real increase in density. With progression there is perforation and destruction of the contour. The author does not make a diagnosis on the roentgenogram alone, as the findings extend, to date, over an insufficient number of cases. If the petrosa is not pneumatized the above changes, of course, are not seen. However, the diploic type may show changes characteristic of osteomyelitis.

The author appends plates with description of the roentgen anatomy. He concludes that operative interference is indicated in cases with positive roentgenograms plus a suggestive clinical syndrome. In addition, cases presenting protracted aural discharge after mastoidectomy on a pneumatic bone should have the petrosa roentgenographed to see whether it is the cause of the chronicity. Finally, it is advisable to roentgenograph the petrosa, as a routine procedure, in every case of acute aural infection.—*E. I. L. Cilley.*

Richards, Lyman. The prognostic significance of sinusitis in children. *Ann. Otol., Rhinol. & Laryngol.*, Dec., 1931, *40*, 1076–1093.

This article is a study of 480 cases of sinusitis treated at the Children's Hospital in Boston over the twelve-year period, 1918 to 1930. Of this group 150 answered questionnaires sent out and 75 returned for roentgen check-ups. The rest of the information is based on hospital records. He divides the treatment instituted into medical—sprays, irrigations, etc.—and surgical—tonsillectomy, turbinectomy, antra puncture, etc.—procedures. He concludes that, if the infection is acute, pyogenic, and is treated by medical or conservative surgical measures, it will generally subside without leaving after-effects aside from a tendency toward recurrent nasal infections. If the disease progresses to a chronic state or is a local manifestation of general systemic allergy or other dysfunction, it will persist until the underlying cause is removed. Tonsillectomy, while frequently of great benefit in affected cases, will not ward off the occurrence of sinus infection, as 62 per cent of the entire group had had their tonsils out.

In general, the existence of nasal symptoms will be found to parallel the existence of a pathologic state in the sinuses as evidenced by the roentgen ray.—*E. I. L. Cilley.*

Mettel, H. B. Xanthomatosis. *Am. J. Dis. Child.*, Oct., 1931, *42*, pt. 1, 858–863.

Mettel reports a case, classifying it as xanthomatosis because of the benign character of the lesion, the membranous defects in the bones of the skull, the response to radium therapy and the tendency to spontaneous remission. The case resembles one of the clinical entities described by Rowland and others. His case had no findings indicative of diabetes insipidus, there was no increase in blood cholesterol or visible exophthalmos as shown by the indistinct outline or early destruction of the orbital fissure. A large defect in the frontal region, as shown in the roentgenogram, practically disappeared after radium therapy.

In 1928, Rowland made a careful study of the reports of cases showing membranous defects in the skull with certain other clinical manifestations, and found that in each of these diseases, the lipoid metabolism was at fault. This syndrome had been grouped under various terms such as: defects in membranous bones, diabetes insipidus, with unilateral exophthalmos, Niemann-Pick's disease, Christian's syndrome and Schüller's disease. Instead of considering them as separate and distinct clinical entities, Rowland considered them as different expressions of the same process and coined the term xanthomatosis to cover the entire group.

Mettel gives in detail the clinical features of the disease as described by Rowland and also the results of treatment. The disease is liable to spontaneous remissions. A diet low in fats, especially cholesterol, should be given. Early prophylactic work on the teeth is of great importance. Good results have been reported with the liberal use of insulin. Sosman has shown that the most satisfactory treatment is direct roentgen irradiation of the involved area. In Mettel's case radium was used.—*R. S. Bromer.*

Bronfenbrenner, A. N. Oxycephaly as a pathogenetic entity. *Am. J. Dis. Child.*, Oct., 1931, *42*, pt. 1, 837–857.

The author attempts to characterize oxycephaly in terms of pathogenesis, and in addition reports 5 cases. Oxycephaly, he states, is described in most of the textbooks as a deformity of the skull with certain morphologic characteristics. An unusually high head and steeply rising forehead constitute the outstanding features of an oxycephalic head. Most

of the reports on oxycephaly were made by ophthalmologists, on patients who sought relief from visual impairment. Naturally, atrophic changes of the optic nerves, being an important, but not a constant, feature in the clinical picture, became too intimately related to oxycephaly.

Bronfenbrenner describes in detail the symptomatology of the condition which may be briefly classed under the following headings: (1) external morphologic features of the head; (2) premature synostosis of the skull sutures; (3) signs due to an increased intracranial pressure; (4) signs referable to the cranial nerves; (5) mental status. He also discusses the pathogenesis of the condition and the bearing of the factors of synostosis on the etiology of the deformity.

In his summary he states that from his study of a series of clinical cases of oxycephaly as well as the data reported in the literature, certain characteristics of a compensatory adjustment mechanism can be noted; thus when a premature closure of the coronary skull suture occurs, it impairs the normal adaptability of the skull to the growing brain of a child, and an effort to meet the demands of the growing brain brings about the oxycephalic deformity.

Factors of the premature synostosis and the subsequent compensatory struggle may naturally damage the brain and its adjacent parts. Most frequently the optic nerve undergoes severe atrophic changes. The degree of damage sustained by the entire brain bears a direct relation to the efficiency of the compensatory process; the less effective the compensatory mechanism has been, the less outspoken are the morphologic features of oxycephaly, and the greater the brain damage to be expected. Hence, a marked mental defect is found in rather mild, atypical cases of oxycephaly(and allied deformities of the skull), while in cases with outspoken oxycephalic features a mental defect might not enter into the clinical picture at all.

Various intracranial infectious processes appear to be the main etiologic factors in the premature skull synostosis of oxycephaly and allied deformities of the skull. The cases reported in his paper, the author believes, emphasize the importance of tuberculosis and especially syphilis as probable etiologic factors of oxycephalic deformity.—*R. S. Bromer.*

Allen, F. M. B., and McClure, H. I. A method of study of intracranial hemorrhage in the new-born infant. *Arch. Dis. Childhood*, April, 1931, *6*, 97–100.

A simple contrivance is described which permits the injection of Röntyum into the cerebral arterial system of still-born babies or those dying shortly after birth. A stereoscopic roentgenogram will then reveal the presence, site, size and number of hemorrhages, in cases of intracranial hemorrhages. Among other advantages, permission to perform a necropsy is unnecessary as there is practically no multilation of the body.—*F. H. Decker.*

NECK AND CHEST

Franklin, Philip, and Orley, Alexander. A simple technique for introducing lipiodol into the lungs. *Brit. M. J.*, Nov. 7, 1931, *2*, 847.

No previous experience is necessary. The equipment consists of one No. 6 or 7 gum elastic catheter, one 40 c.c. syringe and an atomizer containing a 4 per cent solution of cocaine. One nostril, the orthopharynx, and larynx are lightly sprayed with the cocaine solution. The catheter is passed along the floor of the nose until it reaches the posterior pharyngeal wall when, with slightly increased pressure, it passes directly into the larynx. The presence of the catheter in the trachea is verified by listening. Two cubic centimeters of the cocaine solution are introduced through the catheter. The patient is now ready for injection. The patient lies on the fluoroscopic table and the bronchi are slowly filled—the upper lobe bronchi in the Trendelenburg position, the lower in the horizontal. The patient turns from side to side to distribute the oil. Plates are exposed as desired.—*E. I. L. Cilley.*

Armand-Delille, P.-F., and Lestocquoy, Ch. La valeur des radiographies de profil pour le diagnostic topographique des lésions pulmonaires et des dilatations bronchiques. (The value of lateral roentgenograms for the topographic diagnosis of pulmonary lesions and bronchial dilatations.) *Bull. et mém. Soc. méd. de hôp. de Par.*, June 8, 1931, *55*, 965–968.

In the anteroposterior view the inferior lobes of the lungs are hidden behind the diaphragm. With lipiodol injected into the bron-

chial tree one can trace the ramifications behind the liver. If a lateral view is made, the extent of the entire lower lobe can be seen, as can the superior and middle lobes lying behind the heart shadow.

In the lateral view the inferior lobe normally appears as a triangle behind and below the cardiac shadow, limited behind by the posterior costal angle and in front and above by the cardiac shadow, below by the posterior part of the hepatic convexity. Although the vertebral column is projected on this triangle it does not confound the interpretation of the shadows. If in the anteroposterior view there are any abnormal shadows, especially at the borders, a lateral view should be used for a precise localization of lesions.—*Ellsworth Johnson.*

Parenti, Silvio. A proposito di due casi di lobo della vena azygos. (Two cases of azygos vein lobe.) *Radiol. med.*, Oct., 1931, *18*, 1330–1351.

Two cases of vena azygos lobe are described and illustrated with roentgenograms. The vena azygos in the adult normally runs along the right margin of the spinal column to the height of the 4th or 5th dorsal, where it curves forward and a little downward and empties into the vena cava just before it enters the heart. The vena azygos lobe is caused by an anomaly in the course of the vein as a result of which it passes across the right lobe of the lung, producing a supernumerary groove and a supernumerary lobe. It thus acquires a meso-azygos which is to a certain extent double, being made up of two folds of the parietal pleura and two of the visceral pleura. The size of the lobe varies from that of a nut to that of a fist. The two constant roentgen signs of vena azygos lobe are the azygos line and the azygos swelling. At the upper end of the azygos line there is a little triangular shadow. Roentgen examination is always necessary to demonstrate the vena azygos lobe. In doubtful cases stereoroentgenography is valuable. Roentgenologists should be acquainted with the picture of the vena azygos lobe as otherwise it may be misinterpreted and lead to a mistaken diagnosis. There has been a great deal of discussion as to whether the vena azygos lobe can be seen if it is normal but the author decides from a review of the evidence that the azygos line is visible under normal conditions. The vena azygos lobe shows the same pathology as the other lobes of the lung. A vena azygos lobe of normal transparency must be differentiated from thickening of the pleura and chondrocostal calcifications A vena azygos lobe of decreased transparency must be differentiated from retrosternal goiter, hypertrophy of the thymus, malignant and benign tumor of the mediastinum, mediastinal pleurisy and mega-esophagus and vena azygos lobe with increased transparency from mediastinal hernia, annular shadows and deviation of the trachea. These differential diagnoses are discussed in detail.—*Audrey G. Morgan.*

Peshkin, M. Murray, and Fineman, A. H. Acute massive atelectasis and asthma. *Am. J. Dis. Child.*, Sept., 1931, *42*, 590–601.

The authors briefly review the history of acute massive atelectasis with also a discussion of the theories of etiology. From the reports in the literature, acute massive atelectasis of the lungs as a complication of a common ailment like bronchial asthma appears to be a relatively rare condition. All of the cases reported have occurred in adults. In a previous study, Peshkin examined over 500 children with bronchial asthma including 1,000 roentgenograms and failed to find a single case of massive atelectasis, partial or complete, as a non-surgical complication of asthma.

Peshkin and Fineman report in full a case of a boy aged nine, which is believed to be of rare interest because the onset of asthma was initiated by a massive atelectasis of the lung, nontuberculous and without surgical intervention. This patient was admitted during an attack of asthma, showing physical signs, however, of flatness and diminished breath sounds in the left lung and signs of asthma in the right. Five days after admission a plug of mucus was withdrawn by the bronchoscope from the left main bronchus. Roentgenograms the day after admission showed typical changes of massive atelectasis in the left chest. Five days later these signs had disappeared. True bronchial asthma was present for a year after this.

Diseases of childhood such as pertussis, measles, scarlet fever, and pneumonia, as well as operations for the removal of tonsils and adenoids, collectively have been shown to initiate the onset of asthma in about 38 per cent of a series of asthmatic children. In another 3 per cent of the cases, the onset of asthma was initiated by pathologic conditions causing a

partial stenosis somewhere along the tracheobronchial tree. This phase of asthma has been referred to as para-asthma, and the asthmatic symptoms were not relieved by the injection of epinephrine hydrochloride (1:1,000 solution) as long as the partial stenosis was present. The authors consider their case reported in this paper as typical of para-asthma, the onset of the asthmatic symptoms being initiated by some pathologic condition within the thorax, namely, massive atelectasis. Early in the condition, the asthmatic râles were heard throughout the unaffected lung and that portion of the affected lung above the level of complete bronchial obstruction, while below the level of obstruction the breath sounds were entirely absent. Several days later, with only partial bronchial obstruction present, as shown by the displacement of the heart and the elevation of the diaphragm along with the roentgenographic evidence of clearing of the pulmonary field of the affected side, asthmatic râles were heard for the first time throughout both lungs. Epinephrine hydrochloride and morphine sulphate failed to control the asthmatic signs in this stage of the disease as in other instances of para-asthma due to other causes.

This case is of unusual interest in that it involves a condition of para-asthma in a child in whom the onset of the asthmatic state was initiated by acute massive atelectasis (nontuberculous and without surgical indication) of the left lung, and in whom, after the clearing of the atelectasis, the condition of true bronchial asthma was present for over one year. A careful search of the literature by the authors failed to reveal a similar case.—*R. S. Bromer.*

Knutsson, Folke. On intrathoracic neurinomata. *Acta radiol.*, Sept. 30, 1931, *12*, 388–394.

Three cases of neurinoma are described, 2 of which were verified by operation and pathological examination, while the diagnosis in the third was based on the clinical findings and the roentgenogram. Intrathoracic neurinomata are the ones of greatest interest to the roentgenologist. They originate from the roots of the thoracic nerves and have an hour-glass shape with an intraspinal and a paravertebral part. This latter part may extend along the spinal nerve for some distance into the intercostal space or be located in the posterior part of the mediastinum at the side of the spinal column. It appears on the roentgenogram as a massive, well-defined, more or less rounded tumor shadow which occupies quite a typical position in the thorax. Of course it is always extrapleural and in the roentgenogram the pleura from the chest wall can generally be seen reflected over it. The localization alone distinguishes it from mediastinal tumors as well as from accessory goiters and growths of the thymus. It may be impossible to differentiate a neurinoma from a fibroma, sarcoma or other tumor of the connective tissue in the posterior part of the mediastinum. If the tumor is an hour-glass shape it is an argument in favor of neurinoma. Other signs in favor of nerve tumor are spinal pressure symptoms, signs of occlusion in myelography and enlargement of the intervertebral foramen seen in the roentgen picture. In some cases artificial pneumothorax is of service as showing that the tumor does not belong to the lung but is connected with the chest wall. True neurinomata rarely undergo malignant degeneration but neurofibromata may undergo sarcomatous degeneration. Only a few cases of intrathoracic neurinomata have been described in the literature. These three cases are illustrated by roentgenograms.—*Audrey G. Morgan.*

Caussade, G. Deux cas d'opacité arrondie intrathoracique (adénopathie hilaire et cancer du thymus). (Two cases of rounded intra-thoracic opacity (hilar adenopathy and cancer of the thymus).) *Bull. et mém. Soc. méd. de hôp. de Par.*, Nov. 9, 1931, *55*, 1601–1609.

A case is reported of a child of seven in whom there was adenopathy of the left hilus with no calcification. After fits of coughing there was purulent vomitus. Six months later the roentgenogram showed the rounded opacity immediately above the heart. Two years later the patient died of tuberculous meningitis.

A case is also reported in a woman of twenty-five with cancer of the thymus. This was represented on the roentgenogram and screen by a large rounded, deeply opaque intrathoracic shadow occupying the anterior superior part of the thorax on the right. There are four illustrations.—*Ellsworth Johnson.*

Zdansky, Erich. Zur Diagnose der Concretio und Accretio cordis. (On the diagnosis of concretio and accretio cordis.) *Fortschr. a. d.*

Geb. d. Röntgenstrahlen, July, 1931, *44*, 48–60.

Volhard in dealing with adhesive pericarditis differentiated between two types: Those which as a result of fixation to the rigid anterior thoracic wall lead to a systolic contraction of the heart and those which as a result of pericardial thickening influence chiefly the diastole of the heart. This differentiation of Volhard's concerns chiefly the pathogenesis of the two grave forms of pericarditis, a sharp clinical separation not being possible in every instance.

The author, in making a study of several cases, arrived at the conclusion that the respiratory displacement of the mediastinum could be used for differentiation. Thus a respiratorily rigid heart with persisting respiratory mediastinal migration in both right and left lateral views indicates with great probability the presence of adhesions of the heart to the pericardium (concretio cordis cum pericardio), whereas the respiratorily rigid heart with lack of respiratoric migration is significant of adhesions of the pericardium to the anterior thoracic wall (accretio cordis).—*T. Leucutia.*

Arkussky, J. Neue Ergebnisse zur Frage der Orthodiagraphie des Herzens. (New contributions to the subject of the orthodiagraphy of the heart.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1931, *44*, 39–47.

The introduction of orthodiagraphy was hailed as the beginning of a new era in the roentgen diagnosis of diseases of the heart and aorta. Within a short time, however, it was found that the method had many limitations, which more recently induced quite a few roentgenologists to replace its use with that of teleroentgenography. There were especially two factors responsible for this pronounced skepticism concerning the value of orthodiagraphy: first, the apparently paradoxical phenomenon that the volume of the heart physiologically increases during inspiration and decreases during expiration, whereas orthodiagraphy led to exactly the opposite observation, and second, that no standard body measure (height, weight, etc.) could be found which could be made the basis of comparison for the orthodiagraphic dimensions.

Despite these limitations there can be no doubt that orthodiagraphy is of value (1) in estimating quite accurately the heart silhouette as projected on the anterior thoracic wall, a procedure which is more precise than percussion or other methods used for this purpose; (2) in giving a rough idea of the main diameters (oblique and transverse) of the heart, and (3) in furnishing a starting point especially for the less experienced in the evaluation of the dimensions of the heart and aorta. Bordet, in the last edition of his book aiming to overcome some of the above limitations, replaced the determination of the orthodiagraphic diameters (median right, median left, longitudinal, transverse, etc.) with a new method which includes the measurement of the individual segments of the heart as well. According to this method four main points are determined, D, D^1, G and G^1, and the line D D^1 indicates the size of the right auricle (a d), D^1 G^1 the size of the right ventricle (v d), G G^1 the size of the left ventricle (v s) and H v s the size of the convexity of the left ventricle (D being the transverse, L the longitudinal and Q the oblique diameter of the heart).

The author in comparing the size of the various sections of the heart as determined by these newer measurements with the true anatomic size found that there still were a great number of discrepancies.

Bordet himself admits that his chief trouble is the determination of point G^1 which is exceedingly difficult. There is no doubt in the author's mind that the erroneous determination of this point is responsible for many of the above discrepancies. Therefore he devised a new procedure which is as follows: The beat of the heart apex is studied with a small diaphragm. On deep inspiration it is noticed at once that there is a difference in the pulsation of the right ventricle and left ventricle, the zero point corresponding to point G^1. This is marked on the skin and then the rest of the points likewise determined on the basis of the characteristic pulsation.

It was found first that by determining point G^1 in the described manner all dimensions of the heart increase, this leading to orthodiagraphic increase of the volume of the heart during inspiration corresponding to the physiologic increase, whereby the apparent paradoxical phenomenon disappears; secondly, that the heart apex in the normal is formed by the left ventricle. It is recognized, however, that the orthodiagraphic measurements still have only a relative value and that therefore they should

be used only in conjunction with other clinical methods.

The author's series includes 60 cases. Because of this paucity of material no attempt is made as yet to give the "normal values" for the dimensions of various lesions of the heart.—*T. Leucutia.*

Bedford, D. Evan, and Treadgold, H. A. The size of the healthy heart and its measurement. *Lancet*, Oct. 17, 1931, *2*, 836–842.

The authors discuss the correlation of clinical and roentgenologic methods of measurement of the normal heart. They state that the orthodiagraphic means is the most accurate roentgenologic method and that standards of normal measurements by different methods must vary according to the method. They conclude that the normal transverse diameter of the heart may be predicted with reasonable accuracy from body weight in those subjects whose height is ideal for their weight. In others, the height and weight must be taken into consideration in predicting heart size. For those whose weight is greater than the ideal for their height, the heart lies more transversely and may exceed the upper limit of the estimated normal transverse diameter. In those whose weight is below the ideal for their height, the heart lies more vertically and the transverse diameter in a few is less than the estimated transverse diameter, weight being taken as a basis. The observed transverse diameter, expressed as a plus or minus percentage of that predicted from body weight and height, is the best indication of heart size. Taking account of both weight and height, about 85 per cent of normal hearts fall within a range of ±10 per cent of the predicted normal. Less than 10 per cent exceeded the upper limit of ±10 per cent. In borderline cases changes in the silhouette of the heart when it is viewed from different angles is likely, in the hands of an experienced roentgenoscopist, to be of more value than measurements.—*M. T. Harris.*

Paschetta, Vincent. L'encoche oesophagienne du rétrécissement mitral. (The esophageal notch of mitral stenosis.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1931, *19*, 343–346.

In pure mitral stenosis a more or less typical notching of the barium-filled esophagus is observed in the right and left oblique positions due to pressure of the enlarged left auricle. The notch which is two to three fingers wide lies a few centimeters below the aortic arch and a few centimeters above the diaphragmatic dome. Its demonstration has a certain diagnostic importance in the moderately advanced cases of mitral stenosis.—*T. Leucutia.*

Haret and Frain. De la visibilité de l'auricule gauche au cours du rétrécissement mitral. (On the visibility of the left auricle during the course of mitral stenosis.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1931, *19*, 323.

In résumé, patients with mitral stenosis showed at the roentgenoscopic examination an opacity in the zone of separation of the arterial and ventricular pulsations which disappeared at 40° rotation in the right oblique position. The examination of the anatomic specimen in one of the cases revealed that this opacity was due to marked dilatation of the appendage of the left auricle.—*T. Leucutia.*

Seham, Max, Shapiro, M. J., and Hilbert, Eunice H. The early diagnosis of rheumatic heart disease in children. *Am. J. Dis. Child.*, Sept., 1931, *42*, 503–525.

The authors state their purpose in this paper as follows: (1) to classify all patients admitted between the years 1923 and 1930 to the Minneapolis Lymanhurst Clinic for Children; (2) to offer a scheme for the differential diagnosis of heart disease, and (3) to discuss and relate in the order of their importance the five chief methods of diagnosis, namely, (*a*) etiologic, (*b*) structural or anatomic, (*c*) functional, (*d*) roentgenologic and (*e*) electrocardiographic. During the above-mentioned period, 809 children were admitted to the clinic between the ages of five and sixteen. These children were admitted because of signs and symptoms indicative of heart disease or because of so-called rheumatic heart manifestations.

Of the children so admitted, less than one-half actually suffered from organic heart disease. Of those with the latter, 18 per cent revealed congenital heart lesions. In 70 per cent of those having congenital lesions, abnormal roentgen shadows were found.

The different methods of diagnosis mentioned above are fully discussed and the cases are analyzed and tabulated. Of most interest to roentgenologists are the authors' conclusions

in the discussion of the roentgen method of diagnosis. They state that they cannot understand how writers can say that there is little value in the roentgen diagnosis of rheumatic heart disease. It is true that it is not of such differential value when it is necessary to decide whether the patient does not have heart disease or whether the condition is in its later stages, but they have found that it is of special value in the diagnosis of the early stages. It has been the custom of practically all roentgenologists to consider a cardiothoracic index of over 50 per cent in the adult as an indication of an enlarged heart. The cardiothoracic index is supposed to represent the relation of the transverse diameter of the heart at the widest level, which is usually that of the right ventricle, to the widest diameter of the chest. The left auricles, the median convexity and the conus pulmonaris are not included in the measurement. They conclude that the 50 per cent cardiothoracic index as usually used as a normal standard is statistically not reliable. In 66 per cent of normal children the cardiothoracic index is between 44 and 50 per cent and the remaining 33 per cent fall between 41 and 54 per cent. In 25 of 100 consecutive examinations of normal children, one is likely to find a cardiothoracic index of over 50 per cent. The roentgenogram taken at a distance of 6 feet is as reliable for practical purposes of diagnosis in children as the orthodiagram.

It has been shown by a number of investigators that the esophagus is in intimate relation with the posterior border of the heart, and that the lower portion of the esophagus is in contact with the left auricle. An enlargement of the left auricle may produce a compression of the esophagus that is easily detected in films that demonstrate the esophagus filled with barium. The enlargement of the auricle not only will produce a localized compression of the esophagus in its lower portion, but will usually push the esophagus posteriorly so that the space between the spine and the esophagus is diminished in this area. The authors conclude that a positive esophagram reveals a dilatation of the left auricle. This does not appear in children with congenital heart disease, in those with miscellaneous heart disease or in normal children. The esophagraphic results are positive in 55 per cent in cases diagnosed as mitral regurgitation. In this group the esophagram is more sensitive than auscultation. It gives positive observations in 67 per cent in the group diagnosed as double mitral disease and 77 per cent in those with double mitral disease and aortic regurgitation.

According to their statistics, the most reliable means of diagnosis is the history. Rheumatism alone causes 39.3 per cent of rheumatic heart disease; rheumatism in combination with other causes, 83.1 per cent. Growing pains alone are responsible for 2.3 per cent. In regard to the electrocardiagram, the absent iso-electric period in lead II and the delayed P-R interval are indications of active rheumatic infection. The former does not occur when there has been no rheumatism. The so-called functional heart tests are of no value in determining the myocardial sufficiency of the heart. The functional method of diagnosis by the taking of the patient's history is probably the least sensitive of all methods for a diagnosis in the early stages.—*R. S. Bromer.*

Herzog. Bedeutung der Röntgenuntersuchung bei kardialer Lungenstauung. (Significance of the roentgen examination in cardiac pulmonary stasis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1931, *44*, 442–447.

More recent contributions have brought sufficient proof that there are definite types of pulmonary stasis. In the generalized type there is diffuse clouding of the lung fields with enlargement of the shadow of the hilus and great pulmonary vessels, while in the localized type one observes circumscribed areas of various size, not infrequently simulating the picture of miliary tuberculosis. According to Zdansky, these latter changes are due to the fact that the stasis extends in addition to the vascular system also to the lymphatic channels.

The author in making a routine examination in 11 cases of pulmonary stasis secondary to some heart lesion found that there is a great discrepancy between the clinical and roentgen findings. Thus in certain cases the auscultation phenomena were nil whereas the roentgen examination revealed rather extensive changes, and in others the opposite was true. All cases were subjected to intravenous strophanthine therapy, and check-up films made at various intervals revealed clearing up of all the signs incident to the pulmonary stasis. This indicates that serial roentgen examination during the course of the treatment of severe heart lesions is of a certain value inasmuch as it permits the

estimation of the degree of clearing of the secondary pulmonary changes.—*T. Leucutia.*

Marderstеig, Klaus. Persistenz des rechtsseitigen Aortenbogens im Röntgenbild. (Persistence of the right-sided aortic arch in the roentgenogram.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1931, *44*, 163–169.

A case of right-sided aortic arch which was demonstrated roentgenologically is described. The anomaly was associated with a congenital vitium (ventricular septal defect). A very marked displacement (to the left) of the barium-filled esophagus and of the trachea was produced by a diverticulum-like formation of the left-sided aortic stump. In a second case which is only briefly mentioned, a right-sided aortic arch was likewise associated with congenital vitium (pulmonary stenosis and ventricular septal defect). However, here because of the absence of an aortic diverticulum no noteworthy displacement of the esophagus and trachea could be observed.—*T. Leucutia.*

Schatzki, R. Das gestielte Aortenaneurysma. (The pedunculated aortic aneurysm.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1931, *44*, 348–351.

A very unusual case of pedunculated aneurysm of the aorta is described and illustrated with roentgenograms and photographs of the anatomic specimen. The preliminary roentgen examination revealed a rounded shadow in the upper mediastinum which at fluoroscopy moved upwards during swallowing and especially during coughing. This associated movement with the trachea seemed to eliminate the possibility of aneurysm. At post-mortem examination, however, there was found an aneurysm of the pedunculated type simulating a diverticulum of the aorta. The upward movement observed fluoroscopically was no doubt the result of this pedunculation. The conclusion is reached that movability of the upper mediastinal shadow does not exclude the possibility of aneurysm.—*T. Leucutia.*

Kienböck, Robert, and Weiss, Konrad. Ein Fall von Aneurysma dissecans der Brustaorta. (A case of dissecting aneurysm of the thoracic aorta.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Aug., 1931, *44*, 211-214.

A review of the literature revealed that not one single case of dissecting aneurysm had been diagnosed in vivo even after introduction of the roentgen rays, although some 300 cases have been reported. The authors describe a case which they, on the basis of a darker nucleus within the shadow of a diffusely enlarged aorta, diagnosed as dissecting aneurysm of the thoracic aorta. Although no autopsy could be performed the authors believe that the sudden exitus with hemorrhage (from the ruptured aneurysm) served to confirm the diagnosis.—*T. Leucutia.*

Butler, H. B. A case of achalasia of the cardia. *Brit. M. J.*, Sept. 26, 1931, *2*, 565.

The author reports a case with a two-year history. The food gradually worked its way up after some hours. There was no vomiting. There was a feeling of great discomfort in the chest until the food was regurgitated. A barium meal was found entirely in the esophagus after six hours. A soft mercury tube, passed without difficulty, permitted the ingestion of liquids. The patient was taught to pass the tube and sent home. He returned two months later, nearly as bad as ever, and demanded operation which was done in August, 1929. No pathology was found. The cardia showed no hypertrophic muscle and was manually dilated to admit three fingers. Two and a half years later he was still perfectly relieved.

The author concludes that, in the large majority of cases, a cure can be obtained by forced dilatation. He quotes 700 cases at the Mayo Clinic dilated from above by means of the bag, only 3 requiring dilatation from below. Also, he quotes Hurst as finding the mercury tube more simple than the bag and as effective in the majority of cases. In Hurst's one failure the bag was equally ineffective. At operation the cardiac sphincter was divided as in Rammstedt's operation for pyloric stenosis. He quotes Wright as using an inflated bag, under manometer control, with four opaque strips in the wall so that dilatation may be carried out under direct roentgenologic observation.—*E. I. L. Cilley.*

Binney, Horace. Tumors of the diaphragm. *Ann. Surg.*, Oct., 1931, *94*, 524–527.

The author was able to find but 4 case reports of primary tumor of the diaphragm. Two were discovered at operation; one a fibromyoma, the other a fibromyosarcoma. Two were discovered at post-mortem; one a sarcoma, the other a

lipoma. The author's case showed on roentgenographic examination a rounded area of increased density in the right upper lobe and a marked elevation of the right diaphragm. Pneumoperitoneum showed the air bubble between the liver and the diaphragm. At operation a carcinoma, evidently secondary to the tumor of the lung, was found involving the under surface of the diaphragm. Later at autopsy the lung tumor proved to be a carcinoma of bronchial origin.—*J. M. Hilton.*

ABDOMEN

PHEMISTER, D. B., REWBRIDGE, A. G., and RUDISILL, HILLYER, JR. Calcium carbonate gall-stones and calcification of the gall-bladder following cystic-duct obstruction. *Ann. Surg.*, Oct., 1931, *94*, 493–516.

Several cases are reported by the authors to bear out their contention that calcium carbonate stones, or pasty or milky suspensions of calcium carbonate occur following obstruction of the cystic duct due to stone, carcinoma or inflammation. The calcium carbonate is apparently thrown out in mild, rather than severe cholecystitis and comes from the gallbladder wall. Complete obstruction is not necessary, but profuse secretion of mucus is a prominent factor. In some cases of obstruction of the cystic duct there may be degeneration, fibrosis and calcification of the gallbladder wall. This differs from stone formation in that the amount of calcium is smaller and belongs in the class of tissue calcifications. This type of calcification may result in a cemented mass comprising stones, gallbladder wall and even the cystic duct.—*M. T. Harris.*

OVEREND, T. D. The skeleton barium meal in gastric diagnosis. *Brit. M. J.*, Nov. 21, 1931, *2*, 938–939.

The author describes a suitable adherent solution and discusses the technique of coating the stomach. He describes the appearance of the mucosa in the normal, in chronic gastritis, in peptic ulcer, and in gastric carcinoma. A good bibliography is appended.—*E. I. L. Cilley.*

ASTI, LUIGI MARIO. Tumori gastrici perforati—studio radiologico di due casi. (Roentgen study of two cases of perforated tumor of the stomach). *Radiol. med.*, Oct., 1931, *18*, 1277–1288.

Two cases of perforated tumor of the stomach diagnosed by roentgen examination are reported. The first was in a man of forty-eight who was admitted to the hospital with signs of ileus rather than those of perforation. He had pain, which was not violent as it usually is in perforation, but came on rather rapidly and was diffused over the whole abdomen. There was contraction of the abdomen and meteorism, which together with the vomiting suggested occlusion from tumor. His general condition was serious. Disappearance of liver dullness, which was formerly considered a constant symptom of perforation, was not present, but recent statistics have shown that this symptom is not found in more than a fourth of the cases of perforation. Roentgen examination, confirmed by autopsy, showed tumor of the stomach evidenced by irregularity and rigidity of the lesser curvature of the fundus and vegetating masses invading the upper and middle part of the stomach. Perforation was shown by a large sac containing gas in front of the stomach and communicating freely with it. The only differential diagnosis that had to be made was from subphrenic abscess. In addition to the fact that there were no clinical signs of abscess there was no liquid level and the boundary of the sac was rectilinear and not convex.

The second case was in a man of sixty-one who had had intermittent pain for about six months but no sudden and intense pain. The roentgen picture showed an irregularity of the the lesser curvature in the antral zone up to the middle third. There were no peristaltic contractions in this zone. The passage of barium into the duodenum was impeded by rigidity of the pylorus. Perforation was shown by an irregular accumulation of barium outside the lesser curvature which filled when the patient was lying down and tended to empty into the stomach when he was standing. There was another smaller accumulation, probably intrahepatic, communicating with the larger one. The picture was not that of a true acute perforation but that of a gradual perforation following perivisceritis and adhesions.—*Audrey G. Morgan.*

TALAMO, LUCA. Le perforazioni subacute del duodeno. (Subacute perforations of the duodenum.) *Radiol. med.*, Oct., 1931, *18*, 1289–1312.

In addition to cases of acute perforation of the duodenum with violent clinical signs, there are subacute cases in which the patients complain only of vague and inconstant disturbances, sometimes with the picture of ulcer, sometimes that of cholecystitis. Often the physician does not suspect perforation at all. In some cases there is no pain but only a feeling of weight in the epigastrium, and Kunz cites a case in which the patient was able to make a long railway journey sixteen days after a perforation. Such cases are due to encystment in a paraduodenal sac resulting from fibrous adhesions which have surrounded and encapsulated the duodenal extravasation.

Nearly all perforations of the duodenum are in the antero-superior wall. Lauret reports 50 cases of antero-superior perforation in a total of 54 cases; 44 of them were in the bulb, 5 in the second portion and one in the third, in analogy with the frequency of ulcer of the different portions of the duodenum. The characteristic roentgen picture of perforation of the antero-superior wall of the bulb of the duodenum is a semilunar accumulation of gas between the liver and diaphragm. Such a clear zone with the patient standing is almost sufficient of itself for a diagnosis of gastrointestinal perforation. In subphrenic abscess there is a liquid level which is not seen in these pictures. Subphrenic abscess does not indicate perforation of the duodenum unless a fistulous tract can be demonstrated between the abscess and the duodenum. Sometimes however the gas does not collect in the subdiaphragmatic space but in cavities in various locations that have been walled off by adhesions. In some cases there is a fistulous tract between the duodenum and the bile tract. These cases are the easiest to diagnose and show the exact site of the perforation. In rare cases there is a subhepatic encystment from perforation of the anterior surface of the bulb of the duodenum. These are generally cases of chronic ulcer which have had time to bring about parabulbar peritoneal reactions strong enough to hold the peritoneal extravasation.

It is very important in the study of duodenal perforation to recognize duodenal adhesions which are the beginning of most processes that lead to subacute perforation of the duodenum. The roentgen picture of periduodenitis is now quite well known. Following the first work of the Americans, Cole, Leonard, Case and Carman, on the subject it was taken up in France and Italy and studied minutely. Duval and Béclère gave a comprehensive picture of it by means of series of roentgenograms taken in association with roentgenoscopy with the patient standing. In periduodenitis the bulb is caught in meshes of adhesions and contracts energetically, changing its form and position completely. The changes in form are extremely varied.

In regard to the pseudo-diverticular structures sometimes seen in the concavity of the second portion of the duodenum, the author thinks that they are roentgen signs of duodenal perforation resulting from degenerative processes in the pancreas or foci of necrosis in the head of the pancreas. The beginning clinical symptoms in these cases should be carefully considered as they may point to the pancreas as the origin of the disease.

Cases of the various types of perforation of the duodenum are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Arnell, Sigfrid. Roentgenological signs of appendicitical abscess. *Acta radiol.*, Sept. 30, 1931, *12*, 359–368.

The author discusses the literature and describes 17 cases of his own showing the roentgen symptoms in appendicial abscess. Acute appendicitis gives but few and rather unreliable roentgen signs. But post-appendicial abscesses may be diagnosed even without contrast filling of the intestinal canal by the method described by Laurell and Westerborn in *Arch. f. klin. Chir.*, 1927, vol. 147 and *Surg., Gynec. & Obst.*, 1931, vol. 52, p. 804.

If the appendix lies on the median side of the cecum the abscess shows as a more or less large and diffuse shadow surrounded by gas-filled loops of intestine. As a rule, the psoas border is blurred or not visible on account of the edema, and sometimes scoliosis develops. Most of the symptoms seen in para- or peri-nephritis may also appear if the abscess is in this position. The kidney outlines may be more or less indistinct or even invisible. There may be gas in the abscess, which facilitates diagnosis, or it may contain lime incrustations and calculi. If there is a fistula valuable information may be obtained by contrast filling of the cavity. Lateral appendicial abscesses are the most easily diagnosed by roentgen examination. The diagnosis is facilitated by the edema of the abdominal wall as a result of which the subperitoneal layer

of fat in this region vanishes. Sometimes a network of vessels in the subcutis shows very clearly. The abscess shows as a shadow between the abdominal wall and the cecum and often contains gas. The cecum is often compressed or dislocated by the abscess. If the abscess extends upwards between the liver and the abdominal wall there will be symptoms of subphrenic abscess, pleural effusion and reduced mobility of the diaphragm. In children a well filled bladder may look like an abscess, a point which should be borne in mind. The author disagrees with Pohl who says that post-appendicial abscess can seldom be seen without contrast filling.—*Audrey G. Morgan.*

Conway, Francis M., and Hitzrot, James, M. Diverticulitis of the colon: a report of thirty-six cases from the New York Hospital. *Ann. Surg.*, Oct., 1931, *94*, 614–639.

The authors are of the opinion that the varying picture of diverticulitis makes the diagnosis dependent on competent roentgenographic examination of the large intestine. They state that diverticulitis is not primarily a surgical entity, that surgical treatment is indicated only for the complications of the disease such as perforation, abscess, obstruction, and fistula formation. Thirty-six personally observed cases are cited.—*J. M. Hilton.*

Kennedy, Roger L. J., and Weber, Harry M. Polyposis of the colon in children. *Am. J. Dis. Child.*, July, 1931, *42*, 69–76.

Although polyposis of the large intestine is generally considered a disease of children and young adults, there is little reference to the subject in pediatric literature. This is accounted for by the rarity of the condition, only a few cases in patients less than fourteen years of age having been observed, and by the fact that the more refined proctoscopic and roentgenologic methods of diagnosis have not been generally employed. The present opinion seems to be that single polyps or polyps that occur in small numbers are of relatively common occurrence and differ from those making up the picture of generalized, disseminated polyposis which occurs relatively rarely.

A striking feature of diffuse polyposis is the familial tendency. The early age of onset in most cases and the lack of other possible etiologic factors has led to the belief that the lesions are congenital. The polyps tend to undergo malignant change early; such change has been found frequently when patients have been in their early twenties or thirties, and a few cases have been reported in patients in the late years of the second decade. The outstanding symptom is said to be profuse bloody diarrhea. Secondary anemia resulting from melena has been reported as a symptom in several cases, but this was lacking in the authors' cases.

The diagnosis is not difficult. Digital examination of the rectum will frequently reveal the presence of one or more growths, some of which may be pedunculated, and which may be small or rather large, varying from 0.5 to 3 cm. in diameter. On proctoscopic examination, the mucosa may be found widely involved with polypoid growths as far up the bowel as vision is possible. If digital and proctoscopic examinations reveal nothing, the roentgen examination becomes of primary importance as a diagnostic measure. Polyps situated in the more proximal portions of the colon may be visualized by this means. By special technique the bases of the polyps can be outlined in the roentgenogram. The latter shows the extent of the process. Although the disease is called polyposis of the large bowel, 5 cases have been reported in the literature in which polypoid changes were found to extend into the ileum.

Pathologically, the adenomatous structure of these lesions serves to distinguish them from the polypoid formations found in cases of lymphatic pseudopolyposis, pseudopolyposis of chronic ulcerative colitis and dysenteric pseudopolyposis.

In regard to treatment, the choice lies between accepting a high surgical risk (colectomy) with the necessity of permanent ileostomy, or a greatly reduced expectancy of life with termination from carcinoma or its complications.—*R. S. Bromer.*

Eggers, Carl. Diverticulitis and sigmoiditis. *Ann. Surg.*, Oct., 1931, *94*, 648-669.

The author wishes to correct the prevailing idea that the presence of diverticula is a rather innocuous condition. The occurrence of inflammation in the diverticula almost exclusively in the sigmoid is explained by the narrowing of the bowel in this region and the tendency to stasis. Clinically the cases may be divided into simple diverticulitis, diverticulitis with complications resulting from perforation, such as abscess, gangrene, peritonitis, and fistula; di-

verticulitis resulting in intestinal obstruction, and diverticulitis associated with carcinoma. Roentgen examinations are of the greatest value, the barium meal being more applicable in some, the barium clysma in others. Films made after evacuation of the barium clysma are helpful. Twenty-four personally observed cases are reviewed. In 11 cases there was a palpable tumor, roentgen examination proving particularly helpful in this group. Thirteen cases required some type of surgical interference. In a few cases roentgen treatment was apparently of value in aiding the dissolution of the mass.—*J. M. Hilton.*

WOLF, ARTHUR. Untersuchung des pathologischen Rektums. (Examination of the pathologic rectum.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Sept., 1931, *44*, 342–347.

In a previous article (see abstract, this Journal, 1931, *25*, 828), the author published the result of his investigations on the roentgen visibility of the normal rectum (which was divided into two parts, the pars sacralis and the pars perinealis). In this article he describes the present technique of examination (which since writing the first article has been somewhat modified) and the appearance of the pathologic rectum in certain lesions.

For a study of the pars sacralis a localized barium enema is given with the patient erect. The separation of the shadow of the sigmoid from that of the rectum is obtained in the first oblique position. This of course does not exclude the necessity of examination in other positions according to the requirements of the individual case. The examination in the erect position has the advantage that the filling occurs slowly, the barium passing into the sigmoid only after it has completely filled the par sacralis of the rectum. Such a procedure is very important from the point of view of differentiation between tumors and inflammatory processes. As is known, tumors do not have an irritating action on the surrounding tissues, whereas inflammatory processes often lead to very marked spasms. Therefore, if the pars sacralis of the rectum presents a localized filling defect with normal distention of the rest of the bowel wall, a tumor may be assumed, whereas if the filling defect is associated with spasm of the entire lumen (and occasionally a second spastic ring above the defect) one may diagnose an inflammatory condition.

The pars perinealis, which is 8 cm. long, does not fill with the barium enema and therefore cannot be visualized. Only after evacuation of the enema is sometimes a relief image obtained which may help to substantiate the diagnosis. Of course, nearly all lesions within this region are reachable by the finger and thus can be diagnosed by palpation.—*T. Leucutia.*

GENITOURINARY SYSTEM

NUVOLI, UMBERTO, and FANANO, VINCENZO. Alterazioni congenite e funzionali dell'apparato urogenitale e malformazioni della colonna vertebrale. (Congenital and functional changes of the genitourinary system and malformations of the spinal column.) *Radiol. med.*, Oct., 1931, *18*, 1312–1320.

The authors describe the cases of 6 children who had congenital malformations of the genitourinary tract, such as hypospadias, cryptorchism, etc. They made roentgen examinations for the purpose of studying the morphology of the internal genitourinary organs, in which they did not find any abnormalities. They did, however, find quite marked functional disturbances of the kidney pelves and ureters, such as spasm, dilatation and dyskinesia. They also found malformations of the dorso-lumbo-sacral spinal column in all the cases, generally consisting of variations in the number of vertebrae, slight rachischises and total or partial sacralizations. The authors believe that disturbances of innervation brought about by these spinal malformations cause the functional anomalies of the genitourinary system. These functional disturbances therefore are not transitory but follow the individual throughout life, as Nuvoli and Impiombato have shown by the examination of a similar case in an adult. They are a part of the constitution of the individual and bring about conditions favorable to the development of urinary lithiasis. Large racemose calculi filling the calyces and pelves can only be explained by some such mechanism as they take a long time to develop and must therefore be caused by chronic stasis. Renal calculosis as a general rule is caused by spasm which is brought about by imperfect innervation, due in the majority of cases to malformations of the spinal column.—*Audrey G. Morgan.*

LANMAN, THOMAS H., and MAHONEY, PATRICK J. Intravenous urography in infants and children. *Am. J. Dis. Child.*, Sept., 1931, *42*, 611–636.

The advent of intravenous urography was hailed, the authors state, with considerable enthusiasm, as it seemed that by this method diagnosis of disease of the urinary tract would be accomplished much more easily and safely than by the methods then in use. It was hoped it would be of especial value in children and infants by eliminating the difficulties and dangers attending the older methods of cystoscopy and retrograde pyelography.

Lanman and Mahoney report 21 cases in which urography was employed. All the patients were less than twelve years of age. The 21 cases were chosen from their series to illustrate various groups of disorders in infancy and childhood. They include a table showing the pathologic conditions found in 234 cystoscopic examinations immediately preceding their work with intravenous injections of urographic mediums.

Their technique and dosage is described in detail. They think that the films which show the best concentration of the drug in the renal pelves are those taken about forty-five to sixty minutes after injection. In small patients, in whom they were unable to obtain cooperation for a satisfactory film by longer exposures using the Potter-Bucky diaphragm, exposures of one-twentieth to one-tenth of a second are used. Catheterization of the bladder, before the films are taken from forty-five to sixty minutes after injection of the drug, may often result in better visualization of the lower end of the ureters. In spite of reports in the literature regarding the nontoxicity of the drug, greater doses were given to the small patients only after careful consideration. In their experience, severe reaction is unusual, but reaction does not seem to be dependent on the dosage of the drug or on the degree of damage to the kidney present, as shown by the clinical picture and the laboratory examinations.

Except for one fatal case, the only patient having an appreciable reaction was a boy, aged six years and nine months, with obstruction at the outlet of the bladder, who after a full dose of iopax had a rise in temperature, flushing and some nausea and vomiting which lasted for only a few hours.

The paper is profusely illustrated with roentgenograms, in some instances cystograms and retrograde pyelograms being shown with the urograms, contrasting the results with both methods. The greatest number of cases in infants and children requiring urologic examination are those in which there is a considerable degree of pyuria and associated renal damage. In such cases, for the most part, and notably in the pyurias of infancy, in which retrograde pyelography is impossible, intravenous urography has given either no visualization of the kidneys and ureters or so little that reliable information was not obtained. Cases of megaloureter of unknown cause and associated with pyuria form a fairly large group of the disorders of the urinary tract seen in early life. In these cases, cystography usually gives excellent visualization of the entire urinary tract; intravenous urography gives little or none.

In 3 cases of congenital obstruction of the outlet of the bladder with marked pyuria and associated renal damage, little, if any, visualization of the kidneys and ureters was obtained by intravenous urography. In one case, the sole exception, good visualization was obtained. In the large group of cases associated with pyuria, the present mediums for intravenous urography give little, if any, reliable information if the pyuria and associated renal damage are marked. At present, Lanman and Mahoney think that they are unable to predict from the information obtained from the clinical picture and the various tests of renal function which cases will show a reaction from the injection. In some cases of congenital anomaly, intravenous urography alone will establish the diagnosis, as in one of their cases of bilateral polycystic kidney and another of double ureter. In other anomalies, double bladder, with exstrophy of one bladder and epispadias, the information was not conclusive as to whether there was one, two or more kidneys, nor was there any visualization of the ureters of either bladder. This is, however, the only method at present available for obtaining visualization of the kidneys and ureters in such cases.

In the group of cases showing only mild infection of the urinary tract, good visualization is generally obtained by urography. It does not yet give sufficiently good delineation of the urinary tract, however, for differentiation between the clinical picture of acute pyelitis that simulates an acute condition of the appendix and the case of subacute or acute appendicitis in which a mild pyuria may be present. In their experience, intravenous urography is not a sufficiently reliable guide in determining the need for continued treatment by pelvic lavage in

cases of unilateral or bilateral pyelo-ureteritis of moderate severity. Of course, the information obtained by retrograde pyelography alone is not sufficient in these cases, as the symptoms, the duration, the urinary observations, etc., must be considered.

In one case, intravenous urography established the differential diagnosis between new growth of the kidney and new growth of the liver. In another case, where cystoscopy and retrograde pyelography were impossible, tuberculosis of the remaining kidney was demonstrated by intravenous urography. Cases of urinary calculus, especially those with obstruction of urinary outflow, generally give good visualization of the urinary tract, and in many cases, retrograde pyelography may be dispensed with. In one case, intravenous urography gave definite information that had not been obtained by repeated retrograde pyelography, demonstrating no abnormality at the ureteropelvic junction or in the upper calyx of the kidney. In another case the usual intravenous dose of skiodan gave no positive information as to whether there were one or two kidneys. A larger dose of the drug was given and some visualization of the right kidney (a large hydronephrotic kidney) was obtained, but no shadow was seen on the left side. No reaction followed this larger dose, but it was felt that absolute proof of the absence of the left kidney had not been obtained until after exploration. Lanman and Mahoney have not yet reached any definite conclusions as to the relative value of skiodan and iopax.

They conclude that the value of intravenous urography is limited in cases showing a marked degree of pyuria associated with damage of the kidney. The evidence obtained in many such cases is inconclusive and unreliable. Its dangers are slight, but must be considered. Cases should be studied carefully, and all other simpler means of diagnosis, notably cystography, should be employed first; also complete studies of the renal function should be made. In cases not associated with marked pyuria, intravenous urography may often do away with the need of retrograde pyelography; it may sometimes give information not obtained by the latter. Its general use in unselected and not carefully studied cases is to be avoided, on account of both the expense and the uncertainty of the information obtained. It is their belief that at present the value of this method of obtaining visualization of the urinary tract is directly proportionate to the user's knowledge of diseases of the urinary tract in this age group and to his experience and skill in the technical procedure necessary for the adequate study and treatment of these conditions.—*R. S. Bromer.*

SKELETAL SYSTEM

DALE, T. Unusual forms of familial osteochondrodystrophy. *Acta radiol.*, Sept. 30, 1931, *12*, 337–358.

The author describes 3 very unusual cases of systemic disease of the skeleton which he calls osteochondrodystrophy. The disease is familial. Two of the patients were brother and sister and the third has a brother who presents the same condition. The patients show dwarfism, pigeon breast and kyphosis of the spine; the limbs are remarkably long and well developed. The most important changes in the bones are defective ossification of the bodies of the vertebrae with kyphosis and scoliosis, defective development of the epiphysis of the head of the femur and widened acetabulum and minor changes in the shoulder and knee joints suggesting local malacia. In 2 of the cases there was also defective development of the epiphyseal centers in the distal end of the forearm and in the metacarpals.

The author compares his cases with those of the same disease already described in three papers by Morquio, Ruggles and Brailsford. In contradiction with the latter he shows that the skeletal changes in the extremities are markedly different in the different cases. A comparison with chondrodystrophy shows considerable differences between the two conditions. He suggests that the disease is due to some abnormal endocrine function and is a condition intermediate between achondroplasia and local malacia. Plates are given showing roentgenograms.—*Audrey G. Morgan.*

COPELAND, MURRAY M. Skeletal metastases arising from carcinoma and from sarcoma. *Arch. Surg.*, Oct., 1931, *23*, 581–654.

For the purposes of analysis, 334 cases of skeletal metastases from Johns Hopkins Hospital are presented, grouped according to the primary malignant disease, giving the important clinical features, roentgen findings, histogenesis, mode of metastases and the results of treatment.

In the group of 100 cases of mammary carcinoma with metastases to bone the primary

was a scirrhous carcinoma in 58 cases, adenocarcinoma in 6 cases and in other classified types 4 cases or less. Clinically, pain was the most characteristic feature, which may precede roentgen changes from three to eight months. The most common roentgen finding was an osteolytic lesion, the osteoblastic process occurring in outspoken fashion only twice. The mode of metastases appeared to be largely through the lymphatics. Cases in which radical operation is done are likely to show metastases in the spine, pelvis, ribs or femora, while cases in which a simple resection is done show metastases to the shoulder girdle and ribs. This is due possibly to the interruption of the regional lymphatics in the radical operation. Cases treated by radical operation or simple resection showed metastases in $32\frac{1}{2}$ months and 29 months respectively after the first appearance of the tumor. Roentgen therapy was given using 200 kv., 5 ma., 50 cm. distance, 25 cm. sq. portal, filtered through 0.75 mm. copper and 0.1 mm. aluminum. Three thirty minute exposures on consecutive days were given to each portal, four portals being treated. Patients so treated could be expected to obtain much relief of pain and often a few extra months of fairly comfortable life.

The incidence of hypernephroma with bone metastases was 34.9 per cent in 63 cases. The bones most commonly involved were humerus, spine, femora, and pelvis. The process was always of the osteolytic type. Irradiation of the metastatic areas offers as much for the prolongation of life as does surgical intervention or a combination of the two. The tumor is extremely resistant to low voltage irradiation. Unless high voltage is available the patient should be referred elsewhere.

There were 34 cases of cancer of the prostate. The bones most frequently involved were the pelvis and lumbosacral vertebrae. The process was of the osteoplastic type with areas of lighter mottling. Roentgen therapy offers some relief of pain but is not effective in eradicating the lesion or in greatly prolonging life.

In the remaining cases of bone metastases the primary lesion was testicle 2, bladder 1, uterus 5, ovary 1, thyroid 6, lung 4, melanoma 3, and in 31 instances the primary lesion was unknown.—*R. R. Rathbone.*

Tescola, Carlo, and Sandrini, Giovanni. Due casi di fratture rare delle ossa del carpo. (Two unusual cases of fracture of the bones of the wrist.) *Radiol. med.*, Oct., 1931, *18*, 1320–1324.

Isolated fractures of the bones of the wrist have been considered rare, but this is partly because such injuries have been diagnosed as sprains, luxations or contusions, and treated by immobilization without making any roentgen examination. The authors describe 2 cases in which roentgen examination revealed such fractures. The first was in a patient of twenty-one who fell and struck the volar surface of her wrist violently. The pain did not keep her from working at first but she felt formication of all her fingers and acute pain on certain movements of the little finger. Two days later she could not work. Her hand was swollen and edematous, adduction and forced extension of the little finger caused stabbing pain. Moderate pressure on the carpus caused pain at the base of the hypothenar eminence; pressure on the styloid processes of the radius and ulna was painless. Roentgenograms in the dorso-palmar and vertical radio-ulnar directions did not show anything. A picture taken in the oblique supine radiocubital direction showed a fracture of the unciform bone, the unciform process being broken off at its base. Treatment was immobilization for ten to fifteen days followed by massage and hot air.

The second case was in a man of thirty-eight who fell from a height of about 3 meters, striking violently on the hard ground with his hand open and hyperextended. He immediately had intense pain at the hypothenar eminence with swelling and limitation of adduction of the hand. The symptoms decreased and he was able to work. When he came for examination he showed limitation of latero-cubital flexion and moderate pain was caused by pressure on the hypothenar eminence and especially on the pisiform bone and a point corresponding to the anatomical site of the pyramidal bone. Examination of the hand in the dorso-palmar and lateral radio-cubital directions showed the pyramidal bone fractured into three fragments. The treatment in this case was limited to massage and a few applications of Bier's hyperemia.

Roentgen examination is important in such cases for medico-legal purposes.—*Audrey G. Morgan.*

Rogers, S. Perry. A method for determining the angle of torsion of the neck of the femur.

J. Bone & Joint Surg., Oct., 1931, *13*, 821–824.

The neck of the femur is directed forward from the coronal plane to a variable degree. The amount of anteversion or axial rotation, measured in degrees, is called the angle of torsion. The normal angle is generally stated to be 12 to 14°, although in apparently normal femora it may vary between zero and 45°.

In congenital dislocation of the hips the angle of torsion may approach 90°, the head pointing almost exactly forward. In some cases of paralysis of the muscles surrounding the hip a significant increase in the angle of torsion is added to the coxa valga present. In slipped epiphyses, in which the epiphyseal cap is displaced backward, the angle is decreased. In malunited fractures of the neck and upper third of the shaft of the femur, there is often derangement of the angle of torsion. An accurate determination of the angle of torsion is important in many cases.

It is impossible to measure the angle of torsion by physical examination. The information, Rogers states, obtained from an ordinary roentgen examination is not much better. An anteroposterior view with the patellae directed foward, gives accurate information under one condition, namely, when the angle of torsion happens to be exactly 90°, and the head lies directly in line with the shaft.

If the angle of torsion happens to be less than 90° it can be calculated from roentgenograms of the hip region by use of trigonometry. Two views are necessary, the usual one with the patella pointing forward, and one with the thigh rotated inward sufficiently to give a true anteroposterior profile view of the neck. Then the apparent length of the neck, as shown in the first view, divided by the actual length, as shown in the second view, represents roughly the tangent of the angle of torsion. But this computation is open to sources of error: (1) as the thigh is rotated inward, the trochanter moves farther from the film and the distortion due to projection is increased and (2) a true anteroposterior view of the neck is difficult to obtain except by the method of the author.

Rogers' method consists essentially of placing the upper end of the femur in a known position and measuring the rotation of the lower end by using the flexed leg as an indicator. The examination is made on a horizontal fluoroscopic table with the tube placed directly under the hip, the patient lying on the table face downward with the knee flexed at 90°. The thigh is rotated outward until the shadow of the head lies directly in line with that of the shaft. The axial plane of the neck now lies vertical to the table and the leg lies perpendicular to the coronal plane of the thigh. The angle formed between the leg and the table represents the angle of torsion of the neck. Tilting of the pelvis does not introduce error. The only important source of error in this method lies in the lateral instability of the flexed knee under tension. In normal hips, when the thigh must be rotated outward 75° to 80°, this error may be as much as 10° to 15°. It may be measured by bringing the screen down over the knee and noting the position of the leg required to superimpose the shadows of the condyles, and correction made by addition. The examination should require about ten seconds of fluoroscopy, preceding the making of films. Having determined the outward rotation of the thigh necessary to place the axial plane of the neck vertical to the table, films may be made in this position and may be called properly lateral views of the neck. Then by rotating the thigh inward, 90°, from this position true anteroposterior profile views of the neck may be obtained.

The author hopes this method may be found useful in determining the angles of torsion normal at various ages, in the study of dislocated and paralytic hips, in slipped epiphyses, in malunited fractures of the femur, and perhaps in other conditions.—*R. S. Bromer.*

Willis, Theodore A. The separate neural arch. *J. Bone & Joint Surg.*, Oct., 1931, *13*, 709–721.

Willis states that when Kilian, seventy-five years ago applied the term spondylolisthesis to forward displacement of the vertebral column on the sacrum, the condition described was only associated with the pregnant female. It was soon recognized in the male and is now more often identified in the male than in the female, and in the latter sex as often follows injury as pregnancy. From its earliest recognition the displacement had been attributed to a break in the continuity of the bony neural arch, occurring between the superior and inferior articular processes of the last lumbar vertebra. This releases the centrum of the last lumbar vertebra with its superimposed column

from its bony anchorage to the sacrum. Whether the bone defect is the cause of local inflammatory changes, whether the separation is due to lack of fusion of anomalous centers of growth, to injury or to defective ossification of the cartilaginous arch are still matters for discussion.

Among the 1,520 human vertebral columns which Willis studied, 79 were found which showed this defect or break in the neural arch, in one or both of the laminae of one of the lumbar vertebrae, usually the last. In the majority of these, the lesion was situated between the superior and inferior articular processes, so that the stability of the lumbosacral joints depended upon fibrous union between the bone components of the affected neural arch.

Willis thinks that since no known bone pathology suggests a disease process that might produce a narrow transverse fissure of one or both laminae of a vertebra without other tissue involvement, inflammation as an etiological factor may be ignored. The possibilities are then injury and developmental anomaly. The theory of traumatism, forced flexion or hyperextension of the lower back which might fracture one or both laminae of a lumbar vertebra, with mechanical factors consequent upon the upright posture causing separation of the fragments and preventing union, fails to account for unilateral separations. In unilateral defects there is complete lack of callus, lipping or other new bone formation common to fractures. This, Willis, believes, is ample ground upon which fracture as an etiological factor may be discarded. In a number of bilateral separations also, the fragments were found too closely approximated to account for non-union of a fracture.

Willis reviews the embryological development of the lumbar vertebra and reports in addition his own studies. He concludes that this defect, whether unilateral or bilateral, substantiates its essential origin as a skeletal anomaly and assigns a very minor rôle to trauma. Embryologically the defect falls into the category of anomalous ossifications of which there are many other examples scattered over the skeleton. It is an anomaly peculiar to the lumbar region, and may be found in any lumbar vertebra and on either or both of its sides, but is usually confined to the last presacral. Thus spondylolisthesis may be a sign of the anomaly. If trauma occurs it plays a secondary rôle, finding the fibrous tissue in this condition a point of less resistance to strain than bone structure. The defect is common to all races.

Separate neural arch in its origin resembles spina bifida, defective articular processes, and separate bony centers for transverse, mammillary and accessory processes which are peculiarly associated with the lumbar column; it is found more frequently when some other anomaly, such as a twenty-fifth presacral, is present. It is the ultimate result of imperfect ossification, whether this be caused by failure in the ossific process itself or by a defect of the pre-existing cartilage.—*R. S. Bromer.*

DUNN, NAUGHTON. Diagnosis and treatment of common injuries of the knee joint. *Brit. M. J.*, Oct. 10, 1931, *2*, 639–644.

The anatomy of the knee joint is described in some detail. The diagnoses in 522 cases of injury to the knee joint are given; of this series 250 were diagnosed as injuries of the intra-articular cartilages. The diagnosis is based on the history coupled with negative roentgen findings. Thirty-four cases were diagnosed as rupture of the lateral ligaments; 34 cases of loose bodies, and 7 cases of fracture of the tibial spine were diagnosed by the roentgen ray as were 4 cases of traumatic exostoses; 6 transverse fractures and 2 traumatic dislocations of the patella were encountered. Avulsion of the tibial tubercle occurred once, Osgood-Schlatter's disease was found twice, fracture involved the articular surface in 4 cases; hemophilia occurred twice as did Charcot's disease. There were 147 indefinite lesions. Treatment is outlined, special attention being given to removal of the involved intraarticular cartilage, which operation gives excellent results. The author's method and operative approach are illustrated.—*E. I. L. Cilley.*

ACTION OF ROENTGEN RAYS AND RADIUM

ON THE

HEART AND LUNGS

EXPERIMENTAL DATA AND CLINICAL RADIOTHERAPY

BY

A. U. DESJARDINS

MAYO CLINIC

ROCHESTER, MINNESOTA

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ACTION OF ROENTGEN RAYS AND RADIUM ON THE HEART AND LUNGS

RESPIRATORY TRACT

NOSE AND ACCESSORY SINUSES

General Considerations

The radiosensitiveness of the mucous membrane of the nose is uncertain. Experiments on animals to determine the irritability of this structure do not appear to have been made, probably because, aside from tumors, little therapeutic work on this organ has ever been attempted and because attention to the sensitiveness of the nose has never been attracted by reports of injury. Many patients irradiated about the face, including a part or all of the nose, for inflammatory or malignant conditions complain of losing the sense of smell or of peculiar, disagreeable odors. Impairment or loss of olfactory perception suggests that the nasal mucous membrane is affected by irradiation in much the same way as the oral mucosa. As far as disagreeable odors are concerned, patients often have the impression that they can "smell the x-rays," and they describe the odor as pungent. This impression may be produced by ozone and nitrous gases generated by the electrical apparatus supplying the tube or by corona discharge from high tension conductors in the treatment rooms. These factors, however, do not wholly account for the phenomenon because, even when the quantity of such gases is reduced to a minimum by careful correction of the electrical conditions and by thorough ventilation, unpleasant odors are still mentioned by many patients. Moreover, the olfactory aberrations may continue for days or weeks after irradiation. Other significant points are that often patients also complain of a bad taste in the mouth, that the disturbances of smell and taste are roughly proportional to the mass of tissue exposed or to the intensity of irradiation, and that they are independent of the part of the body subjected to the action of the rays. Prolonged observation leads one to think that this peculiarity is probably due, in part, to chemical changes and exchanges within the body related to cellular degeneration caused by the rays. In other words, while the phenomenon may be accentuated by inhalation of noxious gases generated by the electrical apparatus (extrinsic factor), it is partly, if not mainly, caused by modifications in cellular chemistry induced by the rays (intrinsic factor).

Epithelial cells which have the property of producing mucus have been shown to be more susceptible to irradiation, after which they undergo mucoid degeneration, secrete an increased quantity of mucus for one or two weeks, when the production of mucus falls below normal. The degree and duration of such depression depend on the dose of rays to which the cells have previously been exposed. It would be natural to suppose that, since the nasal mucous membrane secretes mucus, the cells that elaborate the secretion should be as radiosensitive as the mucus-producing cells of the salivary glands or intestine. But just as there appears to be a certain difference in susceptibility between the mucus-secreting cells of the salivary glands and intestine, in that those of the former seem to be distinctly more sensitive than those of the latter, it may also be that the sensitiveness of the mucus cells of the nasal mucous membrane may be influenced by factors which do not apply to cor-

responding cells in the other structures mentioned. It is quite possible that, if the question were thoroughly investigated, points of similarity and dissimilarity might be found. Also, the epithelium lining different portions of the cavity and its accessory sinuses may vary in sensitiveness, as the epithelium lining different portions of the pharynx has been shown to vary (Coutard). But, in the present state of our knowledge, the radiosensitiveness of nasal epithelium does not appear to differ much from that of the epithelium of the mouth.

Clinical Considerations

Radiotherapy for Rhinitis and Sinusitis. A few reports of the therapeutic value of roentgen and radium rays for certain pathologic conditions of the nose and its accessory sinuses have appeared in medical records. Osmond (1923) wrote that he had treated twelve patients suffering from acute or chronic inflammation of the antrum and frontal sinus, and that the condition subsided rapidly after small doses of roentgen rays. Pain was quickly relieved, the discharge gradually diminished and ceased, and the patients remained well. Denier (1930) reported having treated with roentgen rays ten cases of frontal or maxillary sinusitis. Both sinuses on one or both sides were exposed, through a single field on the affected side, to 500 R (Solomon) of rays generated at a potential equivalent to a spark-gap of 25 cm., filtered through 8 mm. of aluminium, at a focal-skin distance of 30 cm., and the treatment was repeated eight days later. In eight of the ten cases the headache, secretion and mucous congestion disappeared promptly. In one case the headache subsided but did not disappear completely, and in one instance the coryza recurred.

Pick (1911) treated a patient with chronic rhinitis and purulent inflammation of the antrum by giving radioactive water daily by mouth. The patient was kept at a subnormal atmospheric pressure, and adrenalin also was prescribed. The purulent secretion ceased, and Pick attributed this to the atmospheric pressure. According to Robinson (1930), polypoid sinusitis is characterized by recurring coryza, and the hyperemia and continued exudation of serum favor the development of mucous polyps. The pathologic features include leucocytic infiltration of the mucosa, edema of the connective tissue, hypertrophy of the mucous glands, thickening of the periosteum and finally absorption of bone. The polyps may be myxomatous, adenomyxomatous, or angiomyxomatous. In seven of the forty cases recorded by him as having been treated by combined surgical methods and radium, the asthmatic manifestations were relieved, the mucoid or muco-purulent secretion diminished, the tendency to heachache abated, and a few patients recovered the sense of smell. In a considerable number the interval between recurrences increased distinctly.

While the evidence is meager, the foregoing clinical reports indicate that inflammatory conditions of the nose and accessory sinuses respond to irradiation much as do other inflammatory processes, and the mode of action is probably much the same.

Radiotherapy for Hay Fever. Radiotherapy for hay fever has been tried by Schmidt (1915), who was a victim of the disease. He had given to himself one-third of an erythema dose of roentgen rays of medium quality over the nostrils, through a localizing cone of lead glass. The tendency to sneeze disappeared in a few days, but recurred two weeks later; fresh irradiation had little effect. The symptoms of hay

fever also improved in another patient who was irradiated twice, but the duration of such improvement was not specified. Park (1918) reported two patients who had suffered from hay fever annually for a long time; one, treated over a period of six weeks, obtained relief and remained free from symptoms for three years. The disease then reappeared, and repetition of treatment was again followed by cessation of symptoms; the patient had no further disturbance that season. The other patient had had annual attacks for thirty years, without remission. Treated over a period of four weeks, she did not have any attack that year for the first time. It is uncertain how long this effect may have lasted, but Park claimed it was due to a "remarkable uplift of nerve strength." It is not clear to what this "uplift" refers; probably to the feeling of well-being which accompanied the freedom from those annoying and distressing symptoms which mark hay fever and which Park seems to have mistaken for a direct result of treatment. Laquerrière (1927), having noticed the favorable influence on hay fever in a patient irradiated for cancer of the nose, treated many other cases and claimed variable improvement in every case. Haag and Schreus (1931) exposed the entire nose of sixteen victims of hay fever from one to three times at intervals of two or three days to 120 r of roentgen rays filtered through 0.5 mm. of copper, through a field measuring 6 by 8 cm. The patients did not receive any other treatment. In six cases the results were rated as good; one patient derived temporary improvement; in eight patients the response to treatment was not favorable, and one patient could not be traced. Pollen reactions during the period of roentgen therapy did not appear in some cases; in other cases the number and intensity of the reactions decreased, while in some cases the reactions were exaggerated. An opinion on the influence of irradiation on hay fever can hardly be expressed on the basis of such meager evidence; certainly, there is no ground for enthusiasm, although a more systematic and thorough trial might improve the dubious impression left by the four foregoing reports. Nor can anything be said about the possible mode of action of roentgen and radium rays on a disease the nature and etiology of which are still so obscure.

Radiotherapy for Ozena. Yoel (1926) reported a case of ozena apparently cured by treatment with radium. Carrari (1927) also recorded eight cases of ozena treated by inserting 2.87 mg. of radium in paraffin cylinders into the nasal cavity for fifty to sixty minutes; fetor and the tendency to crust formation diminished, but the atrophic condition of the mucosa persisted. Grauer (1929) treated four cases with roentgen rays, some through one field and some through three fields; the condition of three patients improved, while that of the remaining patient remained unchanged. Many different methods of treatment for this fetid condition have been advocated at one time or another, but none has been distinctly successful. The few foregoing clinical reports of the effectiveness of roentgen rays and radium cannot be said to represent conclusive evidence. No doubt, the condition of some cases can thus be improved, but perhaps not any more than by the systematic application of other methods. At any rate, proof of the superiority of radiotherapy is still lacking.

Radiotherapy for Rhinoscleroma. This is a chronic infectious granuloma, usually occurring first in the mucous membrane of the anterior nares, where it may be confined for some time but whence it may gradually extend to the external aspect of the nose or upper lip, or backward to the nasopharynx, oropharynx, larynx or

trachea. The primary lesions may be found in any of these situations, and the lacrimal ducts, eustachian tubes, hard and soft palate, and even the bronchi may be invaded secondarily. At first hyperplastic and infiltrative in character, the lesions slowly undergo sclerosis, the mucous membrane becomes scarred and atrophic, and concentric stenosis of the nasopharynx with retraction or destruction of the uvula may occur. Prior to 1903, many methods of treatment had been tried, but all were notoriously ineffective. FITTIG (1903) was the first to demonstrate that the lesions of this disease are singularly amenable to the influence of roentgen rays. He reported the case of a woman aged twenty-five years, in whom the disease had first appeared at the age of nine years and had gradually extended since then. Repeated excision having invariably been followed by recurrence and the condition having extended outward and inward to the point of causing pronounced symptoms, exposure to roentgen rays was resorted to. As the treatment progressed the lesions gradually receded and marked improvement resulted. RANZI (1904) recorded another case in a woman aged twenty-six years, with extensive nasal, labial and nasopharyngeal infiltration, in whom thirty-five exposures to roentgen rays in five and a half months caused the lesions to disappear. Having tried the Finsen method in one case without result, VON SCHRÖTTER (1904) successfully treated another patient with radium. FREUND (1905) described one case with extensive infiltration of the nose and upper lip and interference with nasal breathing. The right nasal passage was reduced to a slit, and the left passage was completely blocked; the soft palate also was infiltrated. Twenty-three short exposures to roentgen rays caused the infiltration to disappear almost completely from the nose and lip. Other cases were reported by KAHLER (1905), SCHEIN, and VON NAVRATIL.

POLLITZER (1910) cited the case of a woman aged thirty-seven years, who had had the disease for five years and in whom nasal breathing had gradually become difficult. Intranasal portions of the lesion were twice excised, but the condition recurred and extended until the left nasal passage was completely occluded and the alae nasi were densely infiltrated. Preliminary excision of a large portion of the obstructing, intranasal mass, followed by repeated roentgen-ray treatment, led to complete disappearance of the lesions in six weeks; and the patient was still well three years later. With the apparatus now available, the necessity for so many exposures would no longer exist. Nevertheless, repeated moderate doses would still be preferable to massive irradiation. FIGI and THOMPSON (1928) reported four cases with rhinoscleroma; in two cases the disease extended into the larynx. In all four the condition of the patient improved greatly after treatment with radium, and one patient was still well five years later.

Radiotherapy for Tuberculosis of the Nasal Mucous Membrane. HAVENS (1931) reported five cases of primary nasal tuberculosis in patients aged fifty years or more, with granular masses involving the septum and turbinates. In three of the patients the tuberculous lesions were treated with radium, and two patients were well four and a half months and four years, respectively, following treatment. The third patient had been treated only a short time before, and conclusions could not be drawn.

Radiation Injury to the Nose. HOFER (1924) described the case of a patient aged sixty years who, seventeen days after an operation for diffuse carcinoma of the left

ethmoid sinus, received an application of 30 milligrams of radium daily for seven days,[103] and this was repeated six months later. Slight, transient reddening of the nose and epiphora followed irradiation. The tumor did not recur for years, when reddening of the roof of the nose and a fistula leading into the nasal cavity above the naso-frontal suture appeared. This was regarded as an indication of necrosis of the nasal bone, with sequestrum formation; the possibility of recurrence was not entertained, but might well have been considered.

LARYNX

General Considerations

The specific radiosensitiveness of the normal larynx does not appear to have ever been submitted to experimental test. Our knowledge of such sensitiveness has been derived from practical experience acquired as a result of treating, with roentgen or radium rays, various pathologic conditions of this structure. As the result of prolonged experience with a special method of radiotherapy for epithelioma of the mouth, pharynx, and larynx, COUTARD (1932) has found that the mucous membrane covering the pillars of the fauces and junction of the faucial pillars and uvula is the most radiosensitive. Then, in order of sensitiveness, come the mucous membrane of the hypopharynx, that covering the vallecular region, the mucosa of the pharyngo-laryngeal furrows, and that part of the oral mucosa which covers the floor of the mouth, cheeks, horizontal and vertical branches of the mandible, the laryngeal surface of the epiglottis, the laryngeal portion of the interarytenoid space, the base of the tongue, the vocal cords, and the dorsal and anterior surfaces of the tongue. Such difference in sensitiveness undoubtedly represents a basic property of epithelium in these different regions, but may be partly due to variation in distance and in thickness of the tissues which the rays must traverse before they can affect the mucosa. In view of the small size of the larynx, however, marked variation in the radiosensitiveness of its different parts can hardly be expected. The influence of radiation on experimental tuberculosis of the larynx, it is true, has been investigated in a limited way by Brünings and Albrecht, but while these experiments shed some light on the effect of radiation on tuberculous lesions, they do not enlighten us much on the sensitiveness of the normal larynx.

Animal Experiments

Roentgen Rays. BRÜNINGS and ALBRECHT (1910) investigated the effect of roentgen rays on laryngeal tuberculosis in rabbits. At first, bacilli of the bovine and human types were used for inoculation, but the greater sensitiveness of this animal to the bovine type of organism often led to extensive and fulminating pulmonary tuberculosis. The laryngeal lesions produced by this organism were not suitable for therapeutic purposes. Even with the human bacillus careful dosage was necessary, and often pulmonary tuberculosis could not be avoided. Only sixteen of fifty rabbits proved suitable. The material used for inoculation consisted of a suspension of one or two loopfuls of dried human bacilli in 1 or 2 c.c. of salt solution and sputum containing bacilli. By adding an equal part of 1 per cent potassium hydroxide this could be dissolved into a thready mass containing bacilli distributed so uniformly as to pass through a fine injection needle. This sputum emulsion had the advantage of localizing the injection. For direct inoculation of the larynx a Brünings urethroscope, to which a suitable

[103] Length of daily exposure and conditions of application not specified.

tube was attached, was employed under light anesthesia with a solution of morphine and scopolamine[104] injected by means of a Pravaz needle. Direct laryngoscopy was carried out in a semi-darkened room, with the animals in the dorsal position. When necessary, a 20 per cent solution of cocaine-adrenalin was used to overcome spasm of the glottis. The bacterial emulsion was then injected symmetrically beneath the mucosa, generally in the substance of the vocal cords or in the lateral surface of the subglottic space on both sides. Hemorrhage into the trachea was dealt with by position and swabbing. Some of the animals died of dyspnea within twenty-four hours; in others the inoculation proved unsatisfactory or marked peritracheal, suppurative inflammation interfered with treatment. The larynx of the remaining animals was inspected endoscopically every week. Tuberculous lesions were usually present two or three weeks after inoculation, and they were characterized by distinct, slightly nodular infiltration of the mucosa merging into the surrounding normal tissues. The microscopic features included diffuse studding of the sub-epithelial tissue with round cells surrounding tubercles with beginning central caseation and slight thickening of the overlying epithelium. The glands in the infected area presented round-cell infiltration of the interacinous tissue, but no modification of the acini themselves. The degree and extent of the lesions varied in different animals. Ulceration was rarely noted.

The records of only five rabbits that lived a sufficient time were included. The left side of the larynx of the first animal[105] was irradiated[106] for five minutes eighteen days after inoculation, and the rabbit died nineteen days later. At necropsy, both sides of the larynx were swollen; the infiltration extended to the ventricle of Morgagni and false vocal cord and backward to the arytenoid region. Microscopic examination showed severe and extensive tuberculosis with numerous foci of caseation and marked round-cell infiltration, but it was impossible to recognize any difference in the process on the two sides. The right side of the larynx of the second rabbit[107] was irradiated for eight minutes twenty days after inoculation, and death ensued twenty-one days later. At necropsy, the laryngeal swelling was greater on the left side than on the right; microscopic examination showed the usual appearance of tuberculous infection on the left side, while on the right side the infiltrate was distinctly limited by a band of connective tissue, and only a few of the tubercles exhibited central caseation. The left side of the larynx of the third rabbit[107] was irradiated for ten minutes twenty days after inoculation, and the animal died twenty-six days later. At necropsy, the tuberculous process in the irradiated left half of the larynx showed distinct evidence of healing in comparison with the unirradiated right half; and this was confirmed by the microscopic appearance.

The left half of the larynx of the fourth rabbit[108] was irradiated for ten minutes eighteen days after inoculation, and the animal died twenty-five days later. The tuberculous process was severe and had extended considerably on both sides, but the left side presented marked proliferation of connective tissue, which was lacking on the right side. The left half of the larynx of the fifth rabbit[107] was irradiated for ten minutes, and the animal died forty-six days after infection.[109] Again, the microscopic appearance of the lesions on the two sides of the larynx showed, on the irradiated left side, marked proliferation of connective tissue with a clear tendency of the tubercles to become encapsulated; the connective tissue penetrated and infiltrated the tubercles. Brünings and Albrecht concluded that, since such changes had never been described in connection with laryngeal tuberculosis and since they

[104] Morphine, 0.2 gm.; scopolamine, 0.02 gm.; physiologic salt solution, 10.0 gm.

[105] Infected with bacilli of the bovine type.

[106] Rays generated by a Müller Uri tube, operating with a primary current of 2 or 3 amp., and a secondary current of 0.5 to 0.8 ma.; focal-skin distance, 23 cm. The voltage impressed on the tube and the filtration were not specified.

[107] Infected with bacilli of the human type (sputum).

[108] Infected with bacilli of the bovine type.

[109] The date of irradiation was not given.

occurred only in the irradiated half of the organ, they must have been induced by the action of the rays. They also deduced that roentgen therapy of tuberculous laryngitis in human beings might well be profitable.

Analysis of Experimental Data

Although insufficient in number to be conclusive, the experiments of Brünings and Albrecht indicate that roentgen rays exert a distinct influence on the lesions which characterize tuberculosis of the larynx, and that irradiation of such lesions increases their tendency to heal. This is shown by diminished caseation, increased proliferation of connective tissue, and greater tendency to encapsulation on the side exposed to the rays. The evidence is too meager to give a clear idea of the steps in cellular reaction by which the rays bring about the effects described. If more abundant and more satisfactory evidence of the action of the rays on tuberculous lesions were not available, the observations of Brünings and Albrecht could be regarded as little more than suggestive. However, when they are compared with numerous experiments on the action of roentgen rays on tuberculosis of the iris and cornea, of lymph nodes and other structures, and also with a large number of clinical observations, the results obtained by Brünings and Albrecht and by others are in substantial agreement. Certainly, there is no ground for thinking that the rays act differently on laryngeal tuberculosis than they do on tuberculosis of other structures. Although the early phase of reaction was not described, it is probable that the first effect of the rays is to destroy lymphocytes infiltrating the tubercles and thus to liberate the antibodies previously elaborated within the cells. This is probably followed by phagocytosis of the degenerated leucocytes and by increased lysis and phagocytosis of the infecting bacteria. From what is known of the action of roentgen rays on leucocytes, the next step should be regeneration of lymphocytes by hyperplasia of uninjured cells and replacement of the destroyed cells by proliferated connective tissue. Points that tend to support this view are the absence of noticeable effect on tubercles examined soon after irradiation and the diminished tendency to caseation and gradual increase in connective tissue noted in lesions examined several weeks after exposure. But, as far as the larynx itself is concerned, further and more extensive experiments will be required to settle many details which, for the present, must remain obscure.

Clinical Considerations

Radiotherapy for Certain Diseases of the Larynx. FERRERI (1907) reported successful results from the use of radium for nodular hyperplasia of the larynx in singers, but no one else seems to have tried the method. The very paucity of therapeutic reports on the use of roentgen and radium rays for laryngeal disease, other than tuberculosis and malignant tumors, shows with what deserved respect the larynx is regarded.

Radiotherapy for Tuberculosis of the Larynx. Tuberculous infection of the larynx is usually secondary to pulmonary infection, although in a small proportion of cases it may occur independently of demonstrable invasion of the lungs. Usually also, tuberculosis of the larynx does not occur until after pulmonary lesions have existed for some time and have reached a fairly advanced stage of evolution, but apparent exceptions to this rule are not infrequently encountered. As a rule, tuberculous in-

fection manifests itself by hoarseness and sometimes by dysphagia and pain, but some patients are not aware of any laryngeal disturbance. When present, hoarseness results from infiltration and interference with the vibration of the vocal cords, and dysphagia from inflammatory swelling of the laryngeal structures and mechanical resistance to the distensibility of the esophagus by food. Methods to relieve such symptoms are generally of little avail, and improvement depends chiefly on the behavior of the pulmonary lesions. Therefore, any method that tends to diminish or cure the tuberculous infiltration of the larynx, even though it may not have any influence on the tuberculous process in the lungs, is a boon to the patient.

The first clinical test of the action of roentgen rays on laryngeal tuberculosis appears to have been made by TURNURE (1903), who did not observe any improvement in two cases irradiated for four and six weeks, respectively. BIRKETT (1904) was the first to record the favorable influence of roentgen irradiation in a boy aged fifteen years, one of whose brothers and an uncle had died of pulmonary tuberculosis and who had, at first, tuberculosis of the oropharynx and nasopharynx and later tuberculosis of the epiglottis. The character of the lesions was established by microscopic examination of excised tissue and also by animal inoculation. Curettage and galvano-cautery having proved of no avail, the pharynx was exposed to roentgen rays through the open mouth many times at short intervals (four times a week); the lesions gradually receded and disappeared entirely. Later tuberculous ulceration of the left nostril and septum developed and the uvula also became involved. These lesions were irradiated repeatedly, healed completely, and did not recur; some time afterwards, tuberculosis of the epiglottis, in the form of small round nodules and marked swelling, became apparent. Irradiation of the larynx through the side of the neck caused the lesions to retrogress, and great improvement was perceptible at the time the case was reported. In a preliminary statement concerning two cases, also treated with roentgen rays, CASSELBERRY (1904) stated that improvement in the lesions had not occurred; subsequently, Casselberry (1905) corrected this statement and claimed that in one patient the tuberculous process in the larynx had shown marked improvement. TOUSEY (1904) recorded the case of a woman with tuberculous infiltration of the larynx, whose sputum contained an abundance of bacilli. Exposure to roentgen rays and to Cooper-Hewitt light, combined with applications of high frequency current to the neck and chest, was followed by diminished hoarseness and expectoration, gain in weight and strength, and regression of laryngeal infiltration. WINKLER (1904) treated eleven cases and stated that pain was sometimes relieved, but that it was unwise to expect too much from radiotherapy. Influenced by the impressive and conservative report of Birkett, TURNER (1907) recorded another instance of laryngeal tuberculosis in a girl aged thirteen years, in whom systematic roentgen-ray treatment caused the lesions to heal completely and the symptoms to disappear. Another case, in a man aged thirty years who had tuberculosis of the larynx secondary to infection of the apex of both lungs, was reported by WILMS (1910). The laryngeal condition was complicated by a large subcutaneous, extralaryngeal abscess which was incised, curetted and drained. The patient's neck was then exposed to roentgen rays, and the tuberculous abscess as well as ulceration of the laryngeal mucosa healed rapidly and did not recur. POYET and MÉNARD (1910), on the contrary, did not have any success in many cases treated by them. In

four of ten cases dysphagia was quickly relieved but, with this exception, the tuberculous lesions were not affected. Since their patients were irradiated only twice, their failure is not surprising; the wonder is that even dysphagia was sometimes relieved.

Owing to the imperfect apparatus then available, treatment had to be repeated every few days for a long time. Moreover, since the action of the rays on the tuberculous process was not understood, their therapeutic use was purely empirical. The animal experiments of Brünings and Albrecht (1910) threw a faint ray of light on the problem. By themselves the results of these experiments were suggestive rather than conclusive, but they were considerably strengthened by the experiments of others on the action of rays on tuberculosis of lymph nodes, of the eye and other structures, which confirmed those of Brünings and Albrecht. Since then the number of cases of laryngeal tuberculosis treated with roentgen rays increased until the European war disrupted the work of many medical institutions and altered the character of medical records for several years. When military weapons were laid aside and physicians could resume their usual activities, fresh reports of the favorable influence of roentgen irradiation on tuberculosis of the larynx were made by MENZER (1919), KLEWITZ (1921), SPIESS (1922), HARTOG (1922), DE FLINES (1922), KLEINSCHMIDT (1922), AMERSBACH (1922), KOTTMAIER (1923), BECK (1923) DEBICKI (1924), ITERSON and STEENHUIS (1925), GOLDSTEIN (1927), and others.

The reports of Beck, Debicki, and Goldstein are especially interesting, because they are based on a larger number of cases. Beck recorded thirteen patients, most of whom also had pulmonary tuberculosis; in three patients the disease progressed in spite of irradiation, the condition of three other patients improved slightly, while in the seven remaining patients the laryngeal lesions healed. This experience led Beck to conclude that roentgen-ray treatment is valuable but should not be relied on to the exclusion of other methods. Debicki's report covered sixteen cases with definite tuberculous infiltration of the larynx, with or without ulceration. In the majority the effect of weekly exposure of each side of the neck to rays of medium quality, filtered through 4 mm. of aluminium, was distinctly favorable; laryngeal infiltration and pain diminished and disappeared, and the ulcers healed. Besides absolute rest for the larynx, the patients did not receive any other treatment. Debicki maintained that in most of his cases improvement was due to the use of small or moderate doses, and that large doses such as are commonly employed in treating malignant tumors are to be deprecated. Of eleven cases recorded by Goldstein several were said to have derived considerable benefit from exposure of each side of the neck to 30 per cent of the skin unit dose of rays generated at a potential of 180 kilovolts and filtered through 0.5 mm. of zinc and 3 mm. of aluminium. The effectiveness of irradiation was thought to be greatest in the productive or infiltrative form of tuberculosis, and was attributed to destruction of infiltrating lymphocytes and to secondary ferment action on epithelioid cells.

Even though erroneous diagnosis in a certain proportion of cases may be assumed, a definite effect of irradiation on tuberculous lesions of the larynx can hardly be doubted. Moreover, such effect agrees closely with the changes induced, under experimental and clinical conditions, in tuberculous processes affecting other tissues or structures. As mentioned by Goldstein, there is reason to think that the rays destroy the infiltrating leucocytes, that phagocytes and liberated immune bodies attack and

more effectively destroy the bacilli, and that lymphocytic destruction leads to increased connective tissue repair. This view is supported by much experimental and clinical evidence. Therefore, the degree of leucocytic infiltration and the proportion of connective tissue probably are the main and opposing factors that influence the action of the rays. The last element may also explain why, in tuberculosis as in other forms of chronic inflammation, irradiation must usually be repeated a number of times at suitable intervals. The exceptional radiosensitiveness of lymphocytes may also explain why small doses of radiation suffice to produce the effects noted. The failure of some authors to observe improvement may have been due to absence of leucocytic infiltration in and around the tubercles, too great a proportion of connective tissue, inadequate irradiation, or too large doses.

The foregoing clinical data apparently show that roentgen rays have a definite effect on tuberculous lesions of the larynx and that such radiation is of distinct therapeutic value, but that it cannot be depended on to the exclusion of other methods of treatment. It is now well established that the best results can be obtained only by combining periodic exposure of the larynx to roentgen rays and natural or artificial heliotherapy (entire body).

Radiotherapy for Blastomycosis of the Larynx. NEW (1928) reported two cases of blastomycosis of the larynx, in one of which roentgen-ray treatment combined with potassium iodide by mouth was followed by rapid improvement, and the patient was still well eight years later.

Injury to the Larynx from Excessive Irradiation. The larynx is generally credited with a high degree of resistance to roentgen and radium rays, because, in spite of the large number of patients whose neck has been exposed to the rays as an incident in the treatment of many benign and malignant conditions, only a small number of reports of injury to the larynx has been published. These are of sufficient importance however, to deserve more attention than they have received and to serve as a warning that, even though its tolerance to irradiation is relatively high, the larynx may not be indiscriminately exposed to strong doses of roentgen or radium rays without risk of injury. HAHN (1919) appears to have been the first to draw attention to the possibility of injuring the larynx when, in connection with radiotherapy for tuberculous cervical adenitis, he stated that too large a dose may cause hoarseness lasting several weeks, without any perceptible changes in the overlying skin, and that, if the dose is grossly excessive, edema of the larynx may ensue. HOLFELDER (1921) also mentioned that the larynx may be injured by excessive irradiation for tuberculous adenitis. MARCHIK (1921) reported four examples of such injury. The first was a woman aged thirty-six years who, two years after repeated roentgen irradiation for cervical lymphoma, developed a torpid ulcer on the right side of the larynx and, one year later, increasing hoarseness and dyspnea. The subcutaneous tissues surrounding the ulcer were densely indurated, and this interfered with the movements of the neck and head. Laryngoscopy disclosed reddening and swelling of the laryngeal mucosa, infiltration of the false vocal cords, limitation of movement of the true vocal cords, and narrowing of the glottis. After a difficult tracheotomy, the roentgen ulcer extended to the tracheotomy wound but subsequently healed. The second patient, a man aged twenty-six years, had been irradiated previously for keloids of the neck. Two months later, he became hoarse and swellings appeared in

the neck; the hoarseness subsided in a short time, but recurred later and was accompanied by dyspnea. Swellings on both sides of the neck, edema of the uvula, reddening and swelling of the pharyngeal mucosa, and marked inflammation of the glottis were regarded as manifestations of acute laryngeal perichondritis. A difficult tracheotomy, through densely indurated subcutaneous tissue, was followed by stubborn furunculosis and severe perilaryngeal pain, which required novocain anesthesia. One month later the edema subsided, but purulent expectoration became more and more abundant and fetid. The external aspect of the larynx was full and indistinct, and pressure was painful. After another month, the pain and fever increased, and a fistula appeared near the ring cartilage. Two weeks later, a piece of cartilage was extruded and the condition improved for a time, but early the following year (two or three months later) pulmonary infection with fever was followed by death.

The third patient, a woman aged fifty-six years, operated on twice in four years for goiter, was again operated on two years later for a malignant condition of the neck. Postoperative irradiation for three hours, with rays filtered through 0.5 millimeter of zinc, was followed for some days by pain in the neck, hoarseness, and dysphagia. The soft parts of the neck soon became indurated, the larynx swollen, the laryngeal and upper tracheal mucosa hyperemic, the right vocal cord edematous and fixed, the arytenoid cartilages reddened, and the hypopharynx markedly inflamed. During the next month the condition improved; hoarseness and dysphagia almost disappeared, and the internal aspect of the larynx became normal; the external swelling subsided more slowly. The fourth patient, a man aged fifty-two years, had, from the age of three years, suffered from hoarseness as a result of diphtheritic paralysis of the left vocal cord. The hoarseness having increased in severity and symptoms of tabes dorsalis having appeared, the condition of the larynx was treated as tabetic paralysis of the vocal cords and disappeared after eight months. The hoarseness returned four months later, became complete, and was accompanied by dysphagia. Irradiation for carcinoma of the larynx brought transient improvement, but severe swelling three weeks later made tracheotomy necessary. Dysphagia having continued to increase, the malignant nodes in the neck were completely extirpated and a pharyngostomy was arranged. The soft parts of the anterior portion of the neck were greatly indurated and contracted. Extensive adhesions bound together larynx, muscles, and blood vessels. The larynx was much thickened; the mucosa of the pharynx was friable and edematous, and in the left piriform recess the thyroid cartilage was devoid of perichondrium. The resected larynx showed general perichondritis, and on the left side a suppurating ulcer with thickened margins had eroded the thyroid and ring cartilages. Squamous-cell epithelioma was found in tissue from the ulcer and from the lymph nodes. The sutures did not hold, and fatal hemorrhage resulted. The doses of roentgen rays which these patients had received were not clearly specified, but the relationship between irradiation and the injuries described can hardly be questioned. Marchik assumed that the larynx of these patients was exceptionally sensitive.

Schmidt (1921) described one case in which roentgen-ray treatment (1 E.S.D.) for extensive sycosis did not cause erythema of the skin, but was followed by immediate dryness of the throat, pain and difficulty in swallowing, and paralysis of the right vocal cord. Eight months later, pain in the neck, hoarseness, and stridor re-

quired tracheotomy; this was followed by swelling of the glottis, dysphagia, and necrosis of cartilage which was coughed up. Gastrostomy was performed, but the patient died, and necropsy disclosed induration of the subcutaneous tissues of the neck, necrosis of the mucosa and cartilage of the larynx, thickening of the intima of the small arteries in the irradiated region, thickening of the walls and narrowing of the lumen of the laryngeal vessels, and disappearance from the sublingual salivary glands of secreting parenchyma which was replaced by fat and a large number of round cells. WETZEL (1921) also recorded a case in which a full dose of roentgen rays had been repeatedly given to the neck through three fields.[110] Marked radiodermatitis ensued, the adenitis subsided and the skin healed, but the patient developed increasing hoarseness and dyspnea; tracheotomy was performed, but the patient died four months after the last exposure to the rays. An ulcer of the larynx involved both the true and false vocal cords. HERING (1922) mentioned the case of a patient in whom, after twenty-six exposures to roentgen rays at short intervals for goiter, necrosis of the larynx developed and caused symptoms of respiratory obstruction; the patient died of pneumonia. FEUCHTINGER (1922) described a patient who, nine months after receiving three courses of roentgen irradiation for cervical lymphoma, had to undergo tracheotomy on account of respiratory difficulty. Atrophy and telangiectasis of the skin, scarring, induration and contraction of the soft parts of the neck causing puffiness of the face and pulling the head forward, swelling of the glottis, edema of the posterior wall of the larynx, and nodular thickening of the vocal cords were present. The laryngeal swelling diminished during the next three months.

VON HOFMEISTER (1922) reported three cases.[111] One patient, a man aged sixty-nine years, had undergone two operations during the same year for recurring papilloma of the larynx. A tumor on and below the left vocal cord caused hoarseness. Jüngling, who treated Von Hofmeister's cases, gave to each of two fields 100 per cent H.E.D., which caused the hoarseness to disappear in two months. A second exposure of each of two cervical fields to 80 per cent H.E.D. was followed, in three months, by recurring hoarseness and increasing laryngeal stenosis, for which tracheotomy was performed one month later. The patient had dysphagia, severe pain, paroxysmal cough and stridor, and his general condition was bad. These symptoms were accompanied by swelling, reddening, and muco-purulent secretion, dense infiltration of the tissues over the anterior portion of the larynx and thyroid gland, slight degeneration and marked atrophy of the muscles, with replacement by connective tissue, and chronic interstitial thyroiditis. Gastrostomy was done two days after the tracheotomy, but the patient died two days later. Necropsy revealed ulceration of the right vocal cord, necrosis of the laryngeal cartilages, and edema of the mucous membrane, but evidence of carcinoma could not be found. The second patient, a man aged forty-eight years, had lupus carcinoma of the right vocal cord. Roentgen irradiation[112] caused erythema, desquamation and sloughing of the skin, but the larynx did not react. Three more exposures, at intervals of about one month, reduced the size of the tumor, but edema of the arytenoid cartilage developed. When

[110] At the last irradiation the neck had received twice the dose intended.

[111] These cases were also reported by Jüngling (1923), who gave details of irradiation.

[112] First irradiation: each of 2 converging fields 8 by 10 cm. received 100 per cent H.E.D. of rays generated at 190 kv., and filtered through 0.5 mm. of zinc. Second irradiation: same dose, four weeks later. Third irradiation: same dose, five weeks later.

the patient returned, five months later, he was anemic and in bad general condition, and complained of hoarseness and dyspnea. The skin of the neck was pigmented and the subcutaneous tissue densely infiltrated; whitish necrotic tumor masses appeared in the larynx. Total laryngectomy was performed, but the incision had to be partly reopened to remove necrotic tissue, and the pharyngeal sutures parted. Pneumonia set in thirteen days after extirpation of the larynx, and the patient succumbed in three days. The resected larynx showed loss of striation and fibrous induration of the external muscles, with increase in the interstitial connective tissue, superficial necrosis of the vocal cords, with nests of carcinoma cells in the epithelium, partial ossification of the cartilage, and endothelial proliferation of the blood vessels. The third patient, a man aged fifty-eight years, had an ulcerated epithelioma of the aryteno-epiglottic fold. The first course of roentgen irradiation[113] caused the skin and lymph nodes in the cervical region to swell and the tumor ro retrogress. A second irradiation, seven weeks later, was followed by sharp reaction of the skin and almost complete disappearance of the tumor. After an interval of three months, the left vocal cord became paralyzed, and a large, ulcerated neoplasm was visible in the piriform sinus. A third irradiation[114] resulted in swelling of the neck, aphonia, dyspnea, dysphagia, edema of the larynx, rigidity of the left vocal cord, and disintegration of the growth in the piriform sinus. The skin remained intact, but cyanosis and marked dyspnea required tracheotomy and artificial respiration two months later. The operation was soon followed by swelling of the glottis and ary-epiglottic ligament; the tissue around the tracheotomy wound gradually disintegrated, and death ensued about one month after the operation.

Besides the three preceding cases included in his report, Jüngling (1923) mentioned four additional instances of marked laryngeal reaction leading to death. All had malignant tumors of the neck or larynx and received a maximal dose of roentgen rays through two or more fields on two or more occasions at varying intervals. The malignant growth diminished or disappeared for a time in every case, but became active again later. In at least two of the patients it is impossible to be certain whether death resulted from changes induced by irradiation or from reactivation and extension of the tumor.

Schmiegelow (1922), Blohmke (1922), Burger (1923), Luc (1923), Lehman (1923), Mühlmann and Meyer (1923), Van Rossem (1923), Greif (1923), König (1923), Schmitz (1923–24), Strandberg (1924), Tonndorf (1925), Harris (1925), Clerf (1927), Iglauer (1927), Halberstaedter and Vogel (1927), Pulvermacher (1928), and others also have recorded authentic or doubtful examples of injury to the larynx from exposure to roentgen rays. Many others, including Holfelder (1921), Wintz (1922), Mühlmann (1922), Holzknecht (1922), and Jüngling (1923), have mentioned the danger of excessive irradiation without recording additional examples of actual injury.

Of special interest are the cases described by Van Rossem and by Pulvermacher. Van Rossem's patient was a girl of twenty, whose neck was irradiated[115] for lymphoma. Hoarseness and swelling of the laryngeal mucous membrane developed, but

[113] Irradiated twice with an interval of six weeks; two converging fields, each 8 by 10 cm., received 100 per cent H.E.D. of rays generated at 190 kv.

[114] Three and one-half months later. Probably the same dose to each field.

[115] No details given.

gradually subsided and disappeared. Later, the skin of the neck ulcerated and the subcutaneous tissues became indurated. Six years afterward, the patient returned with hoarseness, swelling of the glottis and edema of the laryngeal mucosa. During the ensuing year the hoarseness continued, severe dyspnea supervened, pain and infiltration of the pharynx developed and caused dysphagia, and the patient died suddenly. Purulent necrosis of the hyoid bone and thyroid cartilage, infiltration of the vocal cords, and marked increase in connective tissue were found at necropsy. This appears to be an undoubted example of roentgen injury to the larynx, although the disease for which the patient was treated may have played a part in the pathologic changes observed. Pulvermacher's patient was a young man aged eighteen years, with an unhealed gunshot wound of the jaw. He had been exposed to roentgen rays thirty times, presumably for diagnostic purposes, had been operated on, and recovered. Five years later, sudden hoarseness and almost complete aphonia resisted treatment, was thoughtlessly regarded as due to roentgen injury, and was presented as such before a medical society, in spite of the fact that the skin of the neck was normal. Two years later the condition recurred, and two specialists were able to establish its hysterical nature by inducing the patient to speak freely and normally. This is an example of the tendency of many physicians unfamiliar with radiation effects to attribute to irradiation any functional or organic disturbance which may arise after exposure. In some of the cases reported, notably in one described by GUSSOW (1927), the relation between irradiation and the symptoms or tissue changes presented by the patient is either spurious or uncertain. Moreover, it must be borne in mind that the cases cited represent but an infinitesimal fraction of the total number of patients in whom the region of the larynx has been exposed to roentgen rays for benign or malignant conditions, without any ill effects. It is unfortunate that so few of those who have recorded accidents of this kind have given a detailed description of the technique and scheme of treatment employed. Nevertheless, it is clear that in many cases the neck of the patient was exposed through two or more fields several times at varying intervals, and that each field received a dose sufficient to cause definite and sometimes marked reaction of the skin and subcutaneous tissues. Under such conditions, it is not surprising that the larynx also should have reacted more or less. The soft parts overlying this structure are not thick, and several beams of radiation converging on it from different directions may easily bring to some portion a dose greater than the tissues can tolerate. The significance of this factor is especially great when the patient is emaciated or naturally thin, and the neck scrawny. Individual variation in sensitiveness between different patients undoubtedly plays a minor rôle.

On the whole, the radiosensitiveness of the larynx is not marked. Ample evidence of this is to be found in the fact that the neck of thousands of patients is being irradiated for various pathologic conditions, not only without injury, but with improvement or cure of the disease for which the treatment is given. Many radiologists of large experience have never seen a single instance of laryngeal injury. PEYSER (1921), BECK and RAPP (1923), and SCHRÖDER (1923), for instance, have reported having irradiated the neck of over one hundred and one hundred and fifty patients, respectively, without the slightest evidence of unfavorable reaction. The danger of injury to the larynx, therefore, may be regarded as relatively slight; but since the

lesions induced by excessive exposure may finally lead to death of the patient, the mere possibility of such injury must command special care. It is probably safe to say that a dose which does not cause the skin of the neck to react will not irritate the larynx. When two or more beams of rays converge on the larynx, however, even though the dose to each separate field may not cause the skin to react, some disturbance of the larynx may be produced. The total depth dose at any point, therefore, must be kept within safe limits.

Radium. The first evidence of injury to the larynx by radium appears to have been submitted by FREUDENTHAL (1904). Application of 0.25 gram of radium for thirty minutes to the larynx of a woman aged thirty-seven years, suffering from tuberculosis of the lungs and larynx with ulceration of the right vocal cord, was followed by congestion and swelling. A similar application on three succeeding days caused marked infiltration of the right vocal cord, thickening of both sides of the larynx, dyspnea, and ulceration in the interarytenoid space, but this subsided in two days; radium applied again on two successive days produced fresh irritation. FREUDENTHAL (1906) mentioned another patient with epithelioma of the larynx, in whom radium filtered through aluminium caused swelling and ulceration, and a laryngectomy was performed to relieve both conditions. FEUCHTINGER (1925) treated a patient with a stenosing scleroma of the larynx by applying several times, for a total of sixty hours, 0.030 gram of radium filtered through 3 millimeters of brass. The condition improved at first, but one month after the last irradiation, acute edema, with complete stenosis of the larynx and odynphagia, resulted. One month later, the temperature rose to 39°C. and the patient expectorated purulent sputum. Extreme edema preventing examination of the larynx, a laryngeal fissure was made under local anesthesia; the entire subglottic mucosa was found gangrenous, and parts of the ring cartilage were undergoing sequestration. Although the fever subsided after removal of the necrotic material, destruction of the cartilage progressed. At the time of the report the wound was improving, but severe stenosis was to be expected.

From the few preceding reports it is obvious that radium also may cause severe injury to the larynx. Indeed, the danger from radium, especially when unfiltered or insufficiently filtered, would be even greater than from roentgen rays if it were as widely used. The fact that so few instances of injury have been recorded is an indication of such restriction to physicians versed in its use and better prepared to avoid overexposure. Also, the tendency to increased filtration tends to diminish the dangerous possibilities.

To be Continued.